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Condition Ratings and Endurance Measures

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(Submitted for publication, September, 1948)

THE study herein reported is concerned with two problems. The first of these considers the question of how successfully an individual can subjectively rate his own state of training or athletic "condition." The second is concerned with certain indices of endurance—in part, with the theoretical bases of these indices, and in part with whether or not there are stable individual differences in endurance as measured by such indices.

SURVEY OF LITERATURE

Defining endurance as the ability to maintain relatively high speed in a long sprint run while taking into account the individual's ability to run fast as measured by a short sprint, Flanagan (5) used the simple ratio of the time scores on the longer run to the short run. McCloy (8, p. 135) has also favored this measure. Cureton (2), seeking an endurance index for swimmers, used the "slowing up in seconds computed cumulatively from lap to lap when a distance of 100 yds. is swum as hard as possible from start to finish." This index he called the "drop-off." Another generally used drop-off index is the difference between the time required for a relatively long run and the time that would have been required had the runner maintained the speed he establishes on a sprint.

Henry and Kleeberger (6) objected to such indices because the index scores of their subjects showed a considerable correlation with times on the short distance, indicating that the index did not achieve its purpose. They contended that endurance (insofar as it could be estimated by a combination of time scores on a short and longer run) could best be measured by the residual scores when the influence of running ability *per se* was partialed out by a statistical procedure. Bell (1) has recently used this method and compared it with the drop-off and ratio indices.

Other indices have been proposed that attempt to correct this situation by some empirical procedure. For example, the *Handbook* tables (4, p. 86) use a ratio index with an additional adjustment for speed in the short dash. A similar empirical modification has been used by Hodgson, *et al* (7).

It would seem that the straightforward solution of the endurance measurement problem might be to have the runners or swimmers all maintain some pre-determined constant pace until they were forced to slow down, so that the decrement in speed or rate of reduction could serve as the endurance index. Unfortunately, such a test would probably be impractical for general use, although it might be valuable as a criterion of endurance.

PROCEDURE

Thirty-five college men were used in the experiment, which was conducted under "field" rather than "laboratory" conditions. Seventeen men were athletes, with two or three representatives from baseball, basketball, football, tennis, field events, track, and one from swimming. There were eighteen non-athletes. The state of training varied considerably.

The men reported to the track in gym shoes and suits. After a conventional type of warm-up that included several practice starts, they were timed on individual 70-yd. dashes by three timers. The times on the three watches were averaged (discarding the occasional figure of a timer who claimed that he had started or stopped his watch incorrectly). The runners were also timed at the 10-yd. mark.

After a rest of 20 to 30 minutes, each subject ran 300 yds. with instructions to go as fast as possible throughout the distance. Additional timers clocked the runner as he passed the 70- and 220-yd. points. Apparently the timing was dependable, for the average intercorrelation between timers was $r = .95$ for the 70, .99 for the 220, and .98 for the 300. The runs were made on an outdoor track that was dry and in good condition, the 70-yd. distance being a straightaway, the 220 including one turn, and the 300 including half of the second turn. About two weeks were required for the experiment. It was possible to secure retests on twenty-six of the men.

Each man filled out a questionnaire that included such questions as, "How well are you trained? — none, slightly, considerably, highly," and, "Do you think you are in poor - fair - good - excellent condition?" The experimenter rated the subjects on similar questions, and also expressed his opinion as to the degree of fatigue exhibited by them as a result of the 300-yd. run.

Even though the men were instructed to run "all-out" throughout the 300, and all stated that they had done so (with the exception of one man, whose time scores did not bear out his observation), the 70-yd. part of the 300 was run three-tenths of a second slower than the separate 70-yd. dash. In view of the 20-30 minute rest, fatigue seems an unlikely explanation. The writer has noticed this tendency in other experiments and believes it to be psychogenic. An all-out run of 300 yds. is a formidable undertaking for most subjects.

A conscious or unconscious tendency to conserve energy in the early part of the run is to be expected. Since this difference was statistically significant, the time on the first dash was used to calculate the indices.

The residual scores were computed by taking the difference between the actual time on the longer runs and the time calculated from the regression equations used to predict the times on these runs from the 70-yd. scores. The regression equation is a statistical technique for predicting the most probable individual scores in a function on the basis of the observed scores in another function. In the present case, the 220 times were predicted from the 70 by the formula 2.45 (70-yd. time) + 6.38, while the formula for predicting 300-yd. time was 3.95 (70-yd. time) + 7.55.

The drop-off index used was the difference between the actual times on the longer run and the times estimated to have been required had each runner maintained in the longer run the speed he established in the 70-yd. dash. Since 220 yds. is equal to 70 multiplied by 3.141, the *estimated* time for the 220 is 3.141 times the 70-yd. score. Similarly, the *estimated* 300 time is 4.286 times the 70-yd. score. In both cases, the drop-off is the difference between *actual* and *estimated* individual time scores.

The ratio indices were 220-yd. time divided by 70-yd. time (220/70 index) and 300-yd. time divided by 70-yd. time (300/70 index). It may be noted that some investigators would calculate these indices as 220-yd. time divided by 3.141 times 70-yd. time and 300-yd. time divided by 4.286 times 70-yd. time. Mathematically, the latter procedure has the effect of multiplying each individual score by a fractional constant but does not influence the relative difference between scores.

For comparison, indices similar to the three types described above were computed from the 300-yd. and 220-yd. time scores. The residual index was the difference between 300-yd. time and 1.35 (220-yd. time) + 2.07, the drop-off was the difference between 300-yd. time and 1.364 (220-yd. time), and the ratio index was 300-yd. time divided by 220-yd. time.

TABLE I

STATISTICAL DESCRIPTION OF PERFORMANCE IN THE RUNS

(Time in seconds)

	First Run	*Second Run*		
n = 35	*70 yd.**	70 yd.	220 yd.	300 yd.
M	8.91	9.26	29.5	41.8
σ	.513	.730	1.98	2.92

* In this and later tables, the first *70* is in italics to avoid confusion with the 70 yd. score of the 300.

TABLE II

CORRELATION (r) BETWEEN ENDURANCE INDICES AND SUBJECTIVE RATING OF CONDITION

n = 35	*Residuals*	*Drop-off*	*Ratio*
300 and *70*	.60	.57	.55
220 and *70*	.58	.48	.51
300 and 220	.10	.08	.03
Mean	.43	.38	.36

EXPERIMENTAL RESULTS AND DISCUSSION

Descriptive statistics of performance on the runs are given in Table I. In Table II, the correlations between the subjective ratings of condition and the several indices of endurance are shown. All endurance indices based on the 70-yd. run yield statistically significant correlation coefficients, the residual score index being somewhat higher in validity than the others. The indices based on the 220 scores fail to show a statistically significant correlation with the criterion, probably because both the 220 and 300 measure a simliar factor that is different (at least in part) from the 70-yd. speed factor. The 70-300 indices are higher in validity than the corresponding 70-220 indices.

Since the 300-yd. run was timed at several intermediate points, t is possible to examine the fractional parts. Table III gives the descriptive statistics, while Table IV shows the intercorrelations and test-retest reliability. The data in both of these tables represent results from only 26 individuals.

TABLE III

STATISTICAL DESCRIPTION OF PERFORMANCE IN THE RUNS AND PARTS OF RUNS (Time in seconds)

n = 26	*70 yd.*	70 yd.	220 yd.	300 yd.	10 yd.	60 yd.	150 yd.	80 yd.
M	8.83	9.19	29.3	41.6	2.03	7.16	20.1	12.3
σ	.476	.636	1.97	3.02	.161	.568	1.49	1.30

TABLE IV

INTERCORRELATIONS (r) BETWEEN THE RUNS AND PARTS OF THE RUNS

n = 26	*70 yd.*	70 yd.	220 yd.	300 yd.	10 yd.	60 yd.	150 yd.	80 yd.
*70 yd.**	*.58*	.76	.80	.78	.66	.74	.75	.56
70 yd.		*.68*	.86	.74	.55	.93	.72	.38
220 yd.			*.87*	.92	.53	.79	.97	.54
300 yd.				*.73*	.47	.68	.91	.83
10 yd.					*.59*	.31	.47	.22
60 yd.						*.64*	.65	.36
150 yd.							*.88*	.57
80 yd.								*.29*

* Entries in italics are test-retest reliability coefficients. The other coefficients are averages of the first and second test correlations.

One of the facts that emerges from these data is that individual runners are not very consistent in their speed pattern in the test and retest 300-yd. runs. The middle 150 yds. is run most consistently

as evidenced by a relatively high reliability. This is true even when allowance is made for the fact that this part of the run samples a larger proportion of the running time than the first or last parts. There are no significant differences in mean times of the test and retest runs or parts of runs—the "t" ratios are below unity except for the 150-yd. part, and even in this case "t" is only 1.4. What has happened is that in the retest, some individuals have run faster in the first part of the 300 than they did in the original test and some have run slower, compensating by slower or faster speed in the later part of the 300 so that the total running time was fairly constant for the complete run.

Individual differences[1] in the performance of the last 80 yds. are substantially non-existent, since the reliability coefficient is only .29. This explains why the reliability of the 300 is less than is found for the 220-yd. scores; quite possibly it also explains why the 300-yd. endurance indices were not very much more valid than the 220-yd. indices. No doubt experienced middle-distance runners would run in a more stereotyped pattern than was found in the present experiment, but it must be kept in mind that an endurance test, if it is to be generally useful, must be applicable to other types of subjects also.

None of the endurance indices is highly reliable, although all are significantly greater than zero. In the case of the 300-yd. data, the reliability coefficient is r = .48 for residual scores, .51 for the drop-off, and .51 for the ratio index. The 220 residual scores also have a reliability of .48, while the drop-off coefficient is .49 and the ratio index, .44. All of these reliability coefficients are considerably lower than the reliabilities of the raw scores on the runs. Again, the explanation would appear to be irregularities in the test-retest velocity patterns of the individual runners. These reliability coefficients may be used to correct the validity coefficients of Table II for attenuation due to unreliability of the endurance indices. The corrected coefficients are shown in Table V. The indication of superiority of the residual score index agrees with the recent finding of Bell (1), who gave running tests to basketball players when out of condition and in condition, and reported a critical ratio of 3.9 for the residual index, 2.9 for the drop-off, and 2.8 for the ratio index.

TABLE V

CORRELATION COEFFICIENTS BETWEEN ENDURANCE INDICES AND SUBJECTIVE RATINGS OF CONDITION, AFTER CORRECTION FOR ATTENUATION

	Residuals	*Drop-off*	*Ratio*
300 and *70*	.86	.79	.78
220 and *70*	.83	.69	.76

[1] Individual differences may be considered demonstrated when the differences in score *between* individuals in the test or in the retest are large as compared with differences *within* the individual from time to time as measured by fluctuations in his test and retest score. Hence the reliability coefficient is a measure of the magnitude of individual differences present.

Examination of the merits of the various endurance indices is aided by recent developments in statistical theory. Investigating the statistical properties of ratio scores such as x/y, DuBois (3) reports that they correlate zero with y only in the special case where $y/x = r_{xy}$ and $Mx = My$, or in the derived form x/x' where x' is the x score predicted from y by the ordinary regression equation. Certain other derived scores also exhibit zero correlation with the factor y, including the residual score method used in the present experiment (which is the rational form that most closely resembles the drop-off index). It should be noted that the difference between the theoretical and empirical formulae is not a simple linear function.

It follows that the ratio index and drop-off index will approximate zero correlation with speed scores to the extent that they approximate one of the theoretically correct methods. In some circumstances, the approximation may be fairly close, but it cannot be expected that this will always happen. For example, in one study (6) the correlation between the empirical ratio index and speed was $r = .50$.

Care must be taken to avoid confusing the endurance index problem with the problem of best predicting some criterion score from the time scores on the short and long runs. In the latter case, prediction efficiency is maximized (theoretically) by employing the multiple regression equation, so that both the speed factor and endurance factor contribute. It happens that in the present study this procedure does not result in much improvement over prediction with the "residual" endurance index—$R = .62$ compared with $r = .60$ for the 300-yd. calculations and $R = .59$ compared with $r = .58$ for the 220-yd. scores[2]—suggesting perhaps that the criterion involved judgment of endurance to a major degree. However, the criterion might very well have been one involving the "speed" aspect of performance or physiology so that endurance was a less important factor. In this case R would have been considerably larger than r, but this would not have invalidated the endurance index.

Unequivocal experimental validation of endurance indices must await the use of an unassailable criterion of endurance measured directly. In the writers' opinion, a good criterion for this purpose would be a fast-paced run, with all subjects running at the same speed as long as they could maintain the pace and thereafter performing according to their individual decrement curves. The common practice of discontinuing and scoring performance on the basis of some arbitrary degree of decrement does not seem acceptable. The remarks of Hodgson, *et al* (7, p. 211-212) are pertinent to this point.

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2 In comparisons employing the coefficient of multiple correlation R, consideration must be given to the fact that this coefficient is automatically adjusted to predict *fallible* rather than *true* criterion scores, hence it overstates the net relationship to some extent.

SUMMARY AND CONCLUSIONS

In order to determine the degree to which "athletic condition" can be subjectively rated, 35 college men performed 70-yd. runs ,followed by 300-yd. runs also timed at the 220-yd. point. Subjective ratings of state of training were also secured. Twenty-six of the men were retested about two weeks later.

The data were also used to compare two empirical indices of endurance, the "ratio" index and the "drop-off," as well as a theoretically derived index consisting of the residual scores obtained by subtracting the times on the longer run from the times for this run predicted from the short run by means of a regression equation. The "residual" index was argued to be a better measure of endurance, in principle, because of independence of the speed and endurance factors.

Analysis of the data led to the following conclusions:

1. Individual differences in "condition" are measurable subjectively, since the ratings correlated from $r = .48$ to $r = .60$ with the endurance indices. Corrected for attenuation due to unreliability of the tests, these coefficients ranged from .69 to .86.

2. Individual speed-patterns in the 300-yd. run varied considerably from test to retest, although individual differences in time scores for the run were fairly reliable ($r = .73$). Time scores for the 220-yd. distance were most reliable ($r = .87$) while times for the last 80 yds. of the 300 showed no significant reproducibility ($r = .29$). The first 70 yds. of the 300 was run 0.3 sec. slower than the separate 70, although the runners claimed to have run at maximum speed throughout the 300 as instructed. Most likely the difference was of psychological origin, rather than an indication of fatigue.

3. Individual differences in endurance, while present to a statistically significant degree, were not very reliable. All indices had a test-retest reliability close to $r = .48$.

4. Endurance indices calculated from 300- and 70-yd. time showed a somewhat higher correlation with condition ratings (av. $r = .58$) than 220- and 70-yd. indices (av. $r = .52$). There was no significant correlation between the ratings and endurance indices calculated from 220- and 300-yd. times ($r = .07$) indicating that 220- and 300-yd. scores measured substantially the same factor, whereas the 70-yd. scores must have included a different factor.

5. Since the multiple correlation between the combined short and long runs and the ratings was not much larger than the correlation between the ratings and index, the ratings probably involved judgments of endurance.

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A Study of Fatigue Effects Induced by an Efficiency Test for College Women

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(Submitted for publication, November, 1948)

COLLEGE women who take strenuous tests frequently complain of excessive fatigue. Those who are responsible for planning testing programs are sometimes hesitant about including strenuous tests because they do not know how seriously to consider the students' comments and outward evidences of fatigue which are observed.

An efficiency, or fitness, test (2, 3) is in regular use in the basic skills program for women at the University of Iowa.* Motivated by student comments and by a desire to know something of the physiological effect of the test, certain information has been obtained from time to time.

The purposes of this study are:

1. To determine the time necessary for recovery from each of the five parts of the efficiency test as determined by pulse rate.

2. To determine the time necessary for recovery from the complete efficiency test as determined by the pulse rate.

3. To determine whether there is a significant loss of steadiness, balance, and strength following the parts of the efficiency test.

4. To compare the effect of one quarter of basketball in a class situation (elementary basketball) with the effect of the efficiency test.

PROCEDURE

It was decided to use the recovery time of the pulse rate as the measure of the effect of test participation. While this is not a comprehensive measure of physiological response, it has been found to give an indication of the strenuousness of activity and the response of the performer to graded intensities of exercise (4, 5).

When the student first reported for the test she was asked to rest on a mat. After five minutes she sat in a chair and the pulse was taken for two consecutive half minutes. If the two counts were not identical the larger of the two was used as the basic resting rate. Following the tests the student was again asked to sit in the chair and the pulse was taken at four half-minute intervals, namely, ½ to

* Description of tests may be found in the appendix.

1 minute, 1½ to 2 minutes, 3½ to 4 minutes, and 4½ to 5 minutes. This procedure was followed with 38 students who were attending regular testing sessions in order to pass this part of the skills requirement. It is assumed they put forth maximum effort during the tests since they knew they must pass at some time.

Twenty-five of these subjects volunteered to continue further with the experiment. Twelve had passed the efficiency test during the first session, and 13 had failed it. Six additional volunteers who had never taken the test joined the group making a total of 31 in the second part of the study.

Each of these subjects came 5 different days at the same hour each day to take one of the 5 tests each day. They were given the pulse, steadiness, balance, and strength tests in this order, before and immediately following each part of the efficiency test. The pulse rate was taken exactly as in the first part of the study. The balance test was one involving balance in two successive movements in planes at right angles to each other.* The push-pull attachment on a hand dynamometer was used to measure arm- and shoulder-girdle strength. This test was used as a means of investigating the possible effect on muscles not actually used in the efficiency test. The strength of the leg extensors was measured on the platform dynamometer, (with belt attachment) in order to study the effect upon the muscles which are used most in the tests. The steadiness test was one in which the student attempted to move a stylus through the center of a narrowing track which was electrically wired to register contacts or errors.

Correlations were computed between successive pre-exercise measures in order to determine reliability and consistency of response by the subject. A plan of rotation was devised so that all subjects would not do the efficiency tests in the same order. This was done to equalize any effect of practice or boredom and loss of interest.

In the second part of the study a pulse ratio was obtained by dividing the first two half-minute intervals after exercise by the half-minute count before exercise. If the test had no effect, the ratio would be 2.0.

The third part of the study involved 36 subjects who were members of elementary basketball classes. The same method was used in getting pulse response, i.e., 5 or more minutes' rest was taken immediately after reporting to class and pulse rate was counted. Then they participated in a regulation 8-minute quarter of basketball on a floor approximately 80 feet by 45 feet; pulse rates were then taken during the five half-minute intervals. Three judges watched the

* Balance test: Sideward hop, forward bend, hold one-leg balance at least 5 seconds. In an unpublished study by M. Gladys Scott and Cornelia Lundquist, this test gave an r of .73 with a composite criterion of balance.

cases during the game and rated for continuous and strenuous activity. In only 5 cases did 2 or more judges consider the subject to be playing an easy, leisurely game; and on only one of the 5 did the 3 judges agree on that point.

ANALYSIS OF DATA

The pulse ratio was computed for each subject on the first two minutes following each test, and the following means for Group 2 were obtained:

After vertical pull	2.01
After obstacle race	2.81
After bouncing	2.92
After sit-ups	2.94
After chair stepping	3.06

Apparently during the first two minutes after all tests except the vertical pull some cardiac response can be expected. The other four tests show results surprisingly similar to each other. For Group 3 after 8 minutes of basketball where they were intermittently playing and standing still, yet playing what was considered an active game, the mean ratio was 2.80.

Clocking of regular testing sessions revealed a minimum of 5 minutes, and an average of 7 minutes, between the various tests in the battery. It seemed essential, therefore, to determine whether the pulse rate was back to pre-exercise level in 5 minutes. Table I shows the critical ratios between pre- and post-exercise rates on each test given separately and on the total battery. The range of pulse rates and the critical ratios on all tests except chair stepping would indicate no significant effect on heart rate in the 4½- to 5-minute interval. This would confirm the procedure of allowing 5 or more minutes between tests and giving the chair stepping last. Also, it is interesting to note by comparison of post-exercise means and of critical ratios that there is apparently greater effect from chair stepping given alone than from the entire battery. There is no basis in these data for explaining this difference but it is possible that the less strenuous tests in the battery serve as a warm-up for the chair stepping when all tests are done consecutively.

The correlation between pre-exercise heart rates on successive days was:

1st and 2nd day	.83
2nd and 3rd day	.96
3rd and 4th day	.93
4th and 5th day	.78

These coefficients would indicate that the rest period allowed was adequate and that the resting pulse rates were satisfactorily consistent.

Post-exercise measures of steadiness, balance, and strength were taken in a time interval of approximately 5 to 8 minutes following

exercise. Table II gives critical ratios between the pre- and post-exercise records of balance, steadiness, and strength when the 31 subjects participated in each of the 5 efficiency tests. That table shows, for this time interval, no significant effect on any of these functions except leg strength. Significant improvement in leg strength is shown after all tests except the vertical pull. While all others were insignificant, all mean differences were in the direction of improvement.

There is no basis in these data to explain the effect on leg extensor strength. However, it would seem to be logical in all cases except after sit-ups. The pull is a momentary effort with no direct effect on legs. The obstacle race, bounce, and chair stepping all use the legs more or less vigorously and the two latter make some demands on general and localized muscular endurance. It is possible that the exercises are such as to evoke the treppe phenomenon in the response of the leg muscles and to leave them at a more effective stage of work than they were before the exercise. The effect of the sit-ups is less clear. It would lead one to believe that it is a circulatory effect.

TABLE I

CRITICAL RATIOS BETWEEN RESTING PULSE RATE AND FIVE MINUTES AFTER EXERCISE*

	Pull	*Obstacle Race*	*Bounce*	*Sit-ups*	*Chair Stepping*	*Total Efficiency Test*	*Basketball*
				Before			
Range	36-49	33-49	34.47	34-48	37-48	33-50	25-61
Mean	41.51	41.06	41.29	41.03	41.19	41.32	39.17
S.D.	3.25	3.20	3.53	3.27	3.06	4.60	6.87
				After			
Range	36-49	36-49	36-48	33-50	38-56	37-57	31-69
Mean	41.48	42.12	43.19	42.90	48.48	45.92	44.50
S.D.	2.97	3.45	3.64	3.38	4.80	5.94	7.85
C.R.	.02	.06	1.67	1.79	6.17	3.77	3.06

* The resting count and post-exercise count were each for a 30-second interval.

TABLE II

CRITICAL RATIOS BETWEEN TESTS GIVEN BEFORE AND AFTER EXERCISE*

	Exercise				
Tests given before and after exercise	*Pull*	*Obstacle Race*	*Bounce*	*Sit-ups*	*Chair Stepping*
Balance	.18	.22	.00	.49	.15
Steadiness (No. of hits)	.37	.35	.14	.10	.40
Steadiness (First hit)	1.10	.51	.33	.00	.30
Arm Strength	1.07	.47	.76	.73	.84
Leg Strength	1.91	5.08	3.11	3.56	4.70

* In every case there was an improvement after exercise.

In order to determine the consistency of performance on the balance, steadiness, and strength tests, correlations were made between performances on successive days. A description of group performance and correlation coefficients for selected days appears in Table III. Consistency is highest in the strength tests; the balance test seems adequate, however. Consistency on the steadiness test appears somewhat questionable but this is understandable for a test of this type when a single trial is given each day.

Five minutes following a quarter of basketball is insufficient for recovery of heart rate as evidenced by the critical ratio of 3.06 (Table I). However, it is customary in the game to allow only 2 minutes' rest, play another 8 minutes, and then, after a 10-minute rest, repeat the procedure. The data obtained on the total efficiency test are quite similar to those on the group playing one quarter of basketball indicating a possible similarity in strenuousness between the total battery and one quarter of basketball. The mean heart rates for the basketball group follow:

Before game	39.17
½ to 1 minute after playing	57.44
1½ to 2 minutes after playing	50.92
2½ to 3 minutes after playing	48.42
3½ to 4 minutes after playing	46.64
4½ to 5 minutes after playing	44.50

It should be noted that this was in a class situation and not a highly competitive game.

INVESTIGATORS' COMMENTS ON STUDENT RESPONSE

Observations on hundreds of students and informal interviews with some students along with the above evidence have lead to several decisions concerning administration of the tests.

TABLE III

CONSISTENCY OF PERFORMANCE ON SUCCESSIVE TRIALS ON EACH TEST

	Group Scores on the Tests						*Correlation Coefficients between Trials*	
	First trial		Second trial		Third trial		First and	First and
Test	M	σ	M	σ	M	σ	Second	Fifth
Balance	7.03	1.85	7.68	1.89	7.16	1.95	.701	.850
Steadiness (No. of hits)	5.39	2.23	4.87	2.76	4.87	3.11	.652	.760
Steadiness (First hit)	20.58	3.11	20.52	3.33	21.19	2.65	.805	.483
Arm Strength	78.71	13.15	80.65	15.40	82.10	12.51	.937	.929
Leg Strength	445.17	117.45	446.78	119.00	453.23	125.00	.916	.950

A very few cases of nausea and similar distress were observed. Interviews with some of these cases revealed that without exception they had eaten (usually candy bars, malted milks, etc.) within the hour preceding the test, sometimes in the dressing room just before coming into the gymnasium. By giving instructions to all students

not to eat immediately before coming, it has been possible to avoid completely the nausea cases.

In the early stages of using this battery the students were instructed to do a short warm-up before starting the test. Some did, but many did not. More recently, a short warm-up consisting of a series of 5 exercises has been given to each girl before she is allowed to start the test. Similarly, at the same time the warm-up was made compulsory, a 2-minute rest following the test was introduced. The student is instructed to lie on her back with feet up against the wall. She is encouraged to flex her legs occasionally; to try to relax completely, including the legs; or to massage the legs lightly if they feel tense. At the end of two minutes, or longer if she chooses, she is sent to the shower. No figures can be presented on the effect of this procedure. However, the number of cases of muscle soreness reported following testing decreased at the time of starting the routine warm-up and rest and have continued at a minimum. It seems logical to assume some connection. Observation of students on leaving the gymnasium has led those giving the test to believe that there is a psychological value to the rest. It is adequate to recover fairly easy breathing, to relieve the legs of tremor and "wobbly knees"; thus the students go to the showers talking about other things, rather than how tired they are.

Such subjective estimates of student fatigue, coupled with the objective evidence presented above, have confirmed the belief that a battery of tests of this type can be administered safely and with a minimum of fatigue to the college woman who is medically sound and in good physical condition.

CONCLUSIONS

On the basis of data obtained in this study the following conclusions seem justified:

1. Recovery, as judged by the return of heart rate to resting level, is adequate at the end of 5 minutes after each separate test except the chair stepping, so that there would appear to be no handicap to performance on the next test.

2. There is a tendency to improve the functions of balance, steadiness, and strength, after each of the tests, though this improvement is statistically significant only in the case of leg strength. The immediate fatigue would not appear to be a safety hazard.

3. The after-effects of the entire battery in which the student works up to the chair stepping appear to be less severe than when doing chair stepping only.

4. There is a similarity in the amount of recovery during the first five minutes following the total battery and following one quarter of basketball.

5. There is no evidence of lasting or excessively severe fatigue from any of the activities studied.

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Appendix

1. *Pull.*—A dynamometer with push-pull attachment is fastened to an adjustable crossbar which is about 6 to 8 inches in front of a flat wall surface. Subject stands with heels, hips, and shoulders held firmly against wall, shoulder lined up with dynamometer. The dynamometer is adjusted to such a height that when the subject grasps the lower handle, the elbow is level with, or slightly higher than the top of the shoulder. Hand is turned with palm toward wall. The subject stretches tall, back firm against the wall and pulls down (in chinning fashion) as hard as possible. There should be no movement of the body. Score is the number of pounds for the right arm only, or left arm if subject is left handed.

2. *Obstacle race.**—The space required is 55 feet by 12 feet; equipment needed includes three jump standards, a cross bar at least 6 feet long, and lines on the floor. Subject starts in a back-lying position on the floor with the heels at line *a*. On the signal, "Ready, Go!" she gets up and starts running toward *J*, stepping with both feet on each of the three spots on the floor, runs twice around *J*, turns back to *d*, goes under the cross bar, gets up on the other side, runs to line *c* and continues running between *b* and *c* until she comes to *c* for the third time. Score is the number of seconds (to nearest .1 second) required to run the course.

3. *Bounce.*—Subject assumes full squat sitting position with back as straight as possible. The arms are placed on the outside of the legs, hands grasping instep or ankle, elbows held firmly extended to immobilize knees. Subject extends ankle, so that she rises to end of toes or slightly off the floor. The pace is set by counting from the timer, one bounce every half second. Subject continues as long as possible. If she loses balance and can re-start within 3 counts, she may continue. Score is the total number of bounces she can perform (count on which she quits minus the count lost during stops).

4. *Sit-up.*—Subject assumes hook-sitting position with feet flat on the floor. Back is straight. Hands are on shoulders and elbows point forward to

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* A diagram of the floor markings may be found in the following sources:
1 Scott, M. Gladys, "Motor Ability Tests for College Women," *Research Quarterly*, 14:4 (December, 1943), p. 402.
2 Scott, M. Gladys, and Esther French. *Better Teaching through Testing*. New York: A. S. Barnes and Company, 1945, p. 137.

rest on top of the knees. When feet are properly placed a partner holds them in position. Subject lies on back to wait for starting signal. On signal she lifts trunk far enough to touch point of elbows to knees, and returns to back lying (back but not head touching). Trunk flexion is encouraged throughout the test and hands must remain on shoulders. The subject may stop, rest, and restart if she wishes. Score is total number of correct movements (up and down) performed in one minute.

5. *Chair stepping.*—Use an 18-inch chair. Subject stands beside chair, one foot on the chair. An assistant stands behind chair and gives a hand to the performer. On signal the subject starts going up and down on the chair as rapidly as possible. She must rise high enough to have the supporting leg entirely straight, but the other foot need not be placed on the chair. She is encouraged to change the leading leg frequently and is given a demonstration of technique for changing while up on the chair. Score is total number of correct movements (up and down) performed in one minute.

T-scales for college women are presented in a previous report(3).

A Study of Twenty Third-Grade Children Exhibiting Extreme Levels of Achievement on Tests of Motor Proficiency

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OBSERVATION of children at any age level discloses that children have developed varying degrees of proficiency in the use of the large muscles in coordinated movement. During infancy and early childhood, many of the most important learnings are of a psychomotor character and as Thorpe (11) points out, these learnings are intimately associated with the normal physical, mental, and social growth of the child. As children grow older proficiency in gross motor activity assumes greater importance as is evidenced by the prestige value placed upon skillful performance by the child's peers. This is borne out by the studies of Bower (2), Hardy (5), Tryon (12), and Sperling (10) which indicate that the self-confidence and social approval gained by the individual skilled in motor activities may be a valuable asset in personality development and in social adjustment.

The pattern of motor development of infants and young children has been studied extensively by Gesell (3), McGraw (7), Shirley (9), and Bailey (1); the influence of such factors as size, strength, physique, and maturation as well as previous experience in motor activities have all been shown to play a definite role in the level of motor achievement gained by young children. Although little experimental evidence is available concerning the influence of emotionalized attitudes toward play, these intangibles, in all probability, influence the pattern of motor development.

While it is generally conceded that the performance curves in many activities begin to level off shortly after three years of age, Gutteridge (4) believes this is due to lack of motivation and to inadequate environmental stimulation rather than to a slowing down of motor growth. Certainly the range in motor proficiency begins to become broader at this age and the gulf between the skilled and the unskilled continues to widen during the school years. Our knowledge of the factors which contribute to this ever-widening

range in motor proficiency is limited, as is our knowledge of how this divergence in motor ability is associated with the total adjustment pattern of the child.

PURPOSE OF THE STUDY

The purpose of this investigation was to study twenty normal third-grade children, ten of whom exhibited a high level of motor achievement and ten of whom showed a low level of motor proficiency in order to:

1. Determine similarities or differences in the physical, mental, and social characteristics of the children making up the two groups.
2. Examine certain factors in the individual life histories of the children exhibiting extreme levels of motor performance.
3. Locate certain factors within the home and within the family background which appeared to be associated with the children in each of the two groups.

PROCEDURE

The test battery utilized for selecting the ten high and the ten low performers was designed by Seils (8) and includes seven items which are common to the play activities of children of this age level. The seven areas of gross motor performance which this test purports to measure are running, jumping, throwing, striking, catching, agility, and balance.

The method used in selecting and refining the individual test items and a discussion of the validity of the tests is adequately covered by Seils (8); the reliabilities which he reports for the individual tests are as follows:

40-yard dash	.904
Standing broad jump	.906
Throw for distance	.982
Striking (pendulum controlled)	.696
Catching (hoop controlled)	.931
Modified side stepping	.956
Balance (stick-test lengthwise)	.789

The tests were administered to a total of one hundred and seventy-two third-grade children consisting of eighty-two girls and ninety boys.

The investigation was restricted to third-grade children for it was felt that by the time children have reached this level most of them have achieved some measure of scholastic and social stability in the school environment. In addition, as Kawin (6) suggests, most of the basic motor skills have become established by the age of seven. Furthermore, Seils' (8) study shows that the variability of perform-

ance in motor skills is not so great for children in the third grade as for those in the first or second grade, thereby more nearly assuring the selection of superior and inferior performers at the third-grade level.

The tests were administered to each of the one hundred and seventy-two subjects and standard scores by sex were computed for each child on each test item. An aggregate score, which was the sum of the standard scores of each of the seven items, was determined for each child. The five boys and five girls having the highest aggregate standard scores and the five boys and five girls having the lowest totals comprised the subjects for this study.

The case-study technique was employed with a view of obtaining an over-all picture, both past and present, of the twenty cases under observation. In order to gain much of this information it was necessary to interview the parents and teacher of each child. To facilitate this, two guide sheets were devised, one to be used for the teacher interview and the other to be employed in the parent interview. Before these instruments were utilized in this study, trial interviews with two teachers and two parents were conducted following which the guide sheets were improved.

The purpose of the teacher interview was to gain specific information concerning the physical, mental, emotional, and social adjustment of the child to the school situation. The school's personal record file on each child was accessible so that much information, particularly that relating to scholastic attainment, was obtained from this source.

The parent interviews were held in the home and extended over a period of one to one and one-half hours. The nature and purpose of the interviews were made clear in each case, although no reference was made to the child's performance on the motor test. All parents and teachers exhibited sincere interest in the study and cooperated fully in the interviews.

The parent interview instrument was designed to obtain specific data pertinent to each child in the following areas:

1. Educational and athletic background of the parents.
2. Early biological and developmental influences playing upon the child.
3. Parent-child relationship.
4. Home responsibility of the child.
5. Provisions for play in the home and community.
6. Early play interests and early use of play materials.
7. Play companions.
8. General type of play activity preferred.

RESULTS

The results are presented solely in terms of gross totals and are so listed in tabular form. The tables are set up to show the comparative frequency of occurrence of certain personal attributes and of certain environmental factors common to each group. In most instances, the traits and factors included in the tables were not common to all the subjects in each group, resulting often in totals under ten.

Table I shows the age, height, weight, and grip strength of each of the twenty cases studied. It will be noted that the mean age, height, weight, and grip strength is greater for the superior performers than for the inferior (Table I).

TABLE I

AGE, HEIGHT, WEIGHT, AND GRIP STRENGTH OF THE TWENTY SELECTED CASES

	Age in Months	*Height in Inches*	*Weight in Pounds*	*Grip (Sum of Right Strength and Left)*
High Performance Group				
Case F-1	104	50¾	58	55
F-2	113	54¼	61	74
F-3	104	56½	60	56
F-4	103	51	61	67
F-5	102	51	56	65
M-1	115	57	65	60
M-2	104	51½	66	80
M-3	104	54¾	72	70
M-4	103	53¼	68	62
M-5	96	53¼	69	80
Means	104.5	53.33	63.6	66.9
Low Performance Group				
Case F-6	98	57½	75	38
F-7	112	48¼	50	40
F-8	99	52	61	38
F-9	94	54	87	56
F-10	104	49¾	54	39
M-6	99	51	51	62
M-7	94	48	51	65
M-8	99	54¾	69	70
M-9	102	50½	62	58
M-10	104	52¾	64	59
Means	100.5	51.85	62.4	52.5

Table II, which gives a comparison of certain school records of the ten superior and the ten inferior performers, shows that a greater

number of children in the superior group had intelligence quotients* of 110 or more and were classed as good or excellent in reading, writing, and comprehension. Fewer children in the superior group gave evidence of nervous tension and none in the superior group was assigned to special classes.

TABLE II

A Comparison of Gross Totals of Certain School Records of the Twenty Selected Cases

Items from School Records	*High Performance Group, No. of cases*	*Low Performance Group, No. of cases*
I.Q. 110 or above	7	2
Reading Ability (Excellent or Good)	7	5
Writing Ability (Excellent or Good)	7	2
Comprehension (Excellent or Good)	7	3
Assigned to Special Classes	0	3
Exhibits Nervous Tension	3	6
Kindergarten or Nursery Training	5	7

Table III, utilizing the classroom teachers' judgments of certain personal and social traits as exhibited by the twenty cases in the classroom and on the playground, indicates that those children who excelled in popularity with their peers, in leadership qualities, in resourcefulness, and who tended to be more frequently cooperative were more often found among the superior performers.

TABLE III

Teachers' Judgments of Certain Personal Characteristics Exhibited by the Twenty Selected Cases

Personal Traits	*High Performance Group, No. of Cases*	*Low Performance Group, No. of Cases*
Popular	9	3
Retiring	0	5
Rejected	0	2
Leader	7	1
Follower	2	8
Cooperative	8	5
Calm	6	2
Tense	3	5
Resourceful	6	2
Imaginative	2	5

The educational and athletic background of the forty parents of the ten superior and the ten inferior performers is shown in Table IV. It will be noted that in the cases studied, the inferior group was more highly weighted with parents having some college training or with

* Pinter-Durost Elementary A Test.

parents having only a grammar school education; whereas, the superior group came from parents primarily high school trained. The influence of active sports interest on the part of the parent in promoting motor development of their children is indicated by the high percentage of the superior children having one or both parents an active participant in some type of athletic activity.

TABLE IV

EDUCATIONAL AND ATHLETIC BACKGROUND OF THE PARENTS OF THE TWENTY SELECTED CASES

Parental Background	*High Performance Group* *Number*	*Per Cent*	*Low Performance Group* *Number*	*Per Cent*
Parents with some College Education	4	20	8	40
Parents Completing High School	8	40	3	15
Parents Having Attended High School Only	6	30	4	20
Parents with Grade School Education Only	2	10	5	25
Children with One or Both Parents Active in Sports	9	90	3	30

Table V illustrates the relative frequency of occurrence of certain factors which may have some bearing upon the physical and motor development of the child. Nine of the ten superior performers were walking by one year of age whereas only three of the ten inferior performers had accomplished this. Feeding difficulties during infancy and complications associated with childhood illnesses occurred more frequently among the inferior performers. However, the incidence of childhood diseases was not different for the two groups. The mother's age at the time of birth was under thirty in the case of

TABLE V

FACTORS ASSOCIATED WITH THE EARLY PHYSICAL DEVELOPMENT OF THE TWENTY SELECTED CASES

Developmental Factors	*High Performance Group* *No. of Cases*	*Low Performance Group* *No. of Cases*
Walking at Twelve Months or Earlier	9	3
Feeding Difficulties	0	7
Complications Associated with Illness	2	5
Mother's Age Under Thirty at Time of Birth	9	5
Difficult Pregnancy or Birth Injury	2	4

nine of the superior group, whereas this was true of but five of the inferior group.

Table VI shows that for the cases considered, the superior group was more frequently concerned with routine responsibilities in the care of the house and grounds than was the inferior group. The importance of frequent parent participation in the play activities of the child is indicated by the fact that eighty percent of the superior group were active in play activities with their own parents; whereas, none of the inferior group had the opportunity to play extensively with their parents.

TABLE VI

HOME RESPONSIBILITIES AND PARENT-CHILD PLAY ACTIVITY OF THE TWENTY SELECTED CASES

Type Responsibility	*High Performance Group No. of Cases*	*Low Performance Group No. of Cases*
Routine Responsibilities in the Care of the House	7	4
Routine Responsibilities in the Care of Yard and Grounds	9	4
Frequent Parent-Child Play Activity	8	0

The play provisions available for the two groups are shown in Table VII. The play facilities in the home were more frequently adequate for the superior group than for the inferior group. Although twice as many members of the inferior group, as compared to the superior group, lived near playgrounds, fewer of the inferior group were regular attenders.

Table VIII shows the degree of interest exhibited by the superior and inferior performers in their early play activities. It should

TABLE VII

PLAY PROVISIONS IN THE HOME AND PLAYGROUND FACILITIES OF THE TWENTY SELECTED CASES

Play Provisions	*High Performance Group No. of Cases*	*Low Performance Group No. of Cases*
Home Provisions		
Adequate Play Area in Own Yard	10	7
Play Room	7	3
Home Gym Equipment	3	1
Playgrounds		
Near (within two blocks of home)	4	8
Frequented Often (twice a week or more)	5	1

be noted that in general the superior group showed, even at an early age, a preference for those activities which involve the use of the large muscles of the body. A higher frequency of non-performance or of only moderate interest in these same activities is noted in the inferior group.

TABLE VIII

SYNOPSIS OF THE EARLY ACTIVITY INTERESTS AND EARLY USE OF PLAY MATERIALS OF THE TWENTY SELECTED CASES

General Activity Interests	*Number Showing Especial Interest or Ability*		*Number Showing Moderate Interest or Ability*		*Number Having No Provisions for Activity*	
	High Performance Group	*Low Performance Group*	*High Performance Group*	*Low Performance Group*	*High Performance Group*	*Low Performance Group*
Blocks	2	4	8	3	0	3
Crayons	5	5	5	5	0	0
Pounding Tables	8	3	1	5	1	2
Kiddy Car	7	2	2	1	1	7
Tricycle	7	4	3	6	0	0
Ice Skates	6	0	4	5	0	5
Roller Skates	6	2	3	6	1	2
Scooter	0	0	6	6	4	4
Bicycle	0	0	8	2	2	8
Climbs Trees	4	0	5	1	1	9
Jumps Rope	5	1	5	5	0	4

The play associates and the type of play activity of the two groups are shown in Table IX. In the cases studied, there was a

TABLE IX

PLAY COMPANIONS AND GENERAL TYPE OF PLAY ACTIVITY OF THE TWENTY SELECTED CASES

Play Associates and Play Activities	*High Performance Group No. of Cases*	*Low Performance Group No. of Cases*
Playmates Most Often Chosen		
Older	5	1
Younger	0	7
Opposite Sex	1	4
Plays Primarily with a Group	8	1
Plays with One or Two Pals	2	9
After-School Activity		
Active Activities	10	0
Passive Activities	0	5
Organized Play Activities	4	0
Random Play Activities	3	8

tendency for the superior performers to select older children as playmates; whereas, members of the inferior group more frequently played with younger children or with children of the opposite sex. Eight of the ten children in the superior group usually engaged in group play activities; whereas, nine of the ten inferior performers confined their play associates to one or two pals. As might be expected, the superior children chose primarily active games as their after-school activity; whereas, the members of the inferior group more frequently selected passive activities.

SUMMARY AND CONCLUSIONS

This investigation has utilized the case-study technique in an attempt to discover certain personal characteristics and environmental factors which are common to ten children of high and ten children of low motor proficiency. The ten superior and ten inferior performers included in this study were selected from one hundred and seventy-two third-grade pupils by a battery of seven gross motor performance tests. The investigation involved a compilation of data from school records and personal interviews with the teacher and parent of each respective case.

The following summarizes the findings of this study:

1. The boys and girls in the group of superior performers tended to be, on the whole, older, taller, heavier, and stronger than the children in the inferior group.

2. The children included in the superior performance group gave evidence of a more satisfactory scholastic adjustment than did the inferior performers as evidenced by the presence of a greater number with high intelligence, excellent or good ratings in reading, writing, and comprehension, and by a lesser number of children assigned to special classes and exhibiting nervous tension.

3. With respect to social qualities and personality traits, as subjectively evaluated by the teacher, children in the superior group tended to be active, popular, calm, resourceful, attentive, and cooperative; whereas, children in the inferior group more frequently showed negative traits, and were more often indicated as being shy, retiring, and tense.

4. Study of the educational background of the forty parents showed that the parents of children from the inferior group were characterized by extremes in that forty percent of the parents had attended college and twenty-five percent had only a grammar school education. On the other hand, seventy percent of the parents of children of the superior group had either attended high school or

were high school graduates. Only twenty percent of the parents of the latter group were college trained.

5. Parents of the superior group were highly active in sports; whereas, very few parents of children in the inferior group participated in any type of athletic activity.

6. More children in the superior group were walking at one year and fewer of them had feeding difficulties during infancy or complications associated with early illnesses, than was the case for the inferior performers.

7. A larger number of children in the superior group than in the inferior group accepted routine responsibilities in the care of the house and yard.

8. Parent participation in the play activities of children in the inferior group was non-existent; whereas, it occurred in eighty percent of the superior cases.

9. The superior group at an early age had a wider variety of play materials necessitating large-muscle activity and on the whole demonstrated a wider range of interests and activity in play than did children of the inferior group.

10. Greater opportunity and provisions for play were associated with the superior group. They not only had more adequate facilities in their own yards, but also more often frequented the playground than did the inferior group.

11. During the period of early childhood, the inferior group showed a preference for fine manipulative activity of a passive nature; whereas, the superior group, even at an early age, leaned toward gross motor skills.

12. The superior group tended in general to select older playmates and to play with many rather than few children; whereas, the opposite was typical of the inferior group.

It must be recognized that the small number of cases studied and the subjectivity of the interview procedure utilized makes hazardous the conclusion of casual relationships. However, the data included in this study would suggest that those children who have attained a high level of motor proficiency tend to be more frequently well adjusted in their school and personal relationships, appear to have had fewer irregularities and difficulties in infancy and early childhood, and appear now to have more wholesome and well integrated personalities. This study further suggests that parental interest, as indicated not only by provision of adequate play facilities, but also by active parental participation in the child's activities, is an important factor in helping children gain a high level of motor development.

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The Physiologic Effects of Abdominal Cold Packs

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It has been reported that cold hip baths were employed in Germany during the last World War as a conditioning device in both industry and in the air force. It is assumed that this type of bath was employed before work to prolong the onset of fatigue, and after work to hasten recovery from it. The beneficial results claimed by those who had first-hand information encouraged further investigation of the device.

If, by the process of applying cold to man's mid-section, fatigue can be warded off or recovery from fatigue facilitated, a useful tool is available for use by athletes who participate in strenuous bouts of exercise of relative short duration. It is a common observation that in such sports as basketball, team members frequently exhibit inferior performances during the second half of a game. This loss in capacity to play is, no doubt, due to fatigue. It is obvious that any device which lends itself either to warding off fatigue or which facilitates recovery is useful to coaches of almost every type of sport as well as to anyone engaged in strenuous exercise.

A review of the literature yields but little information relative to any phase of the effects of cold hip baths. This is evidently due to the fact that either quantitative data were not recorded or facilities were not available for reporting them. Recently, in this country, Steinhaus and Kelso (1) investigated the effect of cold hip baths on visual and other functions. They found that this device caused a striking but temporary improvement in visual functions involving binocular vision, visual acuity, and in critical fusion frequency. In addition, the cold hip bath brought about a temporary improvement in tapping rate and in eye-to-leg muscle reaction time. Steinhaus and Kelso report that these effects lasted two and one-half to six hours without any after depression. Also, it was found by these investigators that diastolic blood pressure rose consistently from six to ten mm.Hg.

The object of this investigation is (1) to gain further information relative to the beneficial effects of the local application of cold on recovery from fatigue, and (2) to show the effects of the local

application of cold on some of the physiologic responses involved in recovery from fatigue.

The first problem was approached by comparing the maximum amount of work a subject would do before and after ten minutes of rest, first without and then with an ice pack applied to his abdomen during the rest period.

In an attempt to explain any effects which the abdominal ice packs might have on recovery from fatigue, an attempt was made to show their effects on various physiologic mechanisms involved in work and recovery. The mechanisms investigated were as follows:

1. Body temperature.
2. Basal metabolic rate.
3. Oxygen required to perform a given amount of work.
4. Venous blood pressure.
5. Diastolic and systolic blood pressure.
6. Pulse rate.

Subjects used in this study were volunteer men who were graduate students in the department of physical education. All were in excellent physical condition and health. Their ages ranged from twenty-five to thirty-five years, and their weights ranged from 130 pounds to 200 pounds. No effort was made to condition the men to any of the equipment except for the maximum work output measurements. However, the oxygen consumption experiments were made on men who had had previous experience in the physiology laboratory both in breathing oxygen from a spirometer and in riding the bicycle ergometer.

TECHNIQUES

1. *Maximum work output.*—The bicycle ergometer was employed for measuring maximum work output and any given amount of work required by the experiment. The details of the technique employed have been described by Tuttle and Wendler (2).

In the maximum work output experiment it was important to condition the subjects to the riding of the bicycle. This was done in the following way:

1st Day: 30-second ride, ten-minute rest (longer if necessary), 30-second ride.

2nd Day: Same as 1st day but with only ten minutes' rest.

3rd Day: 60-second ride, 10 minutes' rest (longer if necessary), 30-second ride.

4th Day: Same as 3rd day but with only ten minutes' rest.

During the practice trials the ice pack was not used. The preliminary work was primarily a problem of conditioning the men to the use of the bicycle.

The work output experiment consisted of one minute of maximum work, a ten-minute rest period, followed by an additional one minute of maximum work on the bicycle ergometer. On alternate days the same subject repeated the work experiment but on this occasion ice was applied to the abdomen during the ten-minute rest period.

2. *Body temperature.*—Temperatures were taken orally for a period of four minutes before and at the end of the ten-minute application of ice.

3. *Basal metabolic rate.*—The standard clinical method was employed for measuring basal metabolic rate. Two consecutive six-minute recordings were made, with a ten-minute rest period separating the measures. During a given experimental period two measures were made on each subject under normal conditions, establishing a normal both before and after the ten-minute rest period. At a later date two more measures were made, the first under normal condi-

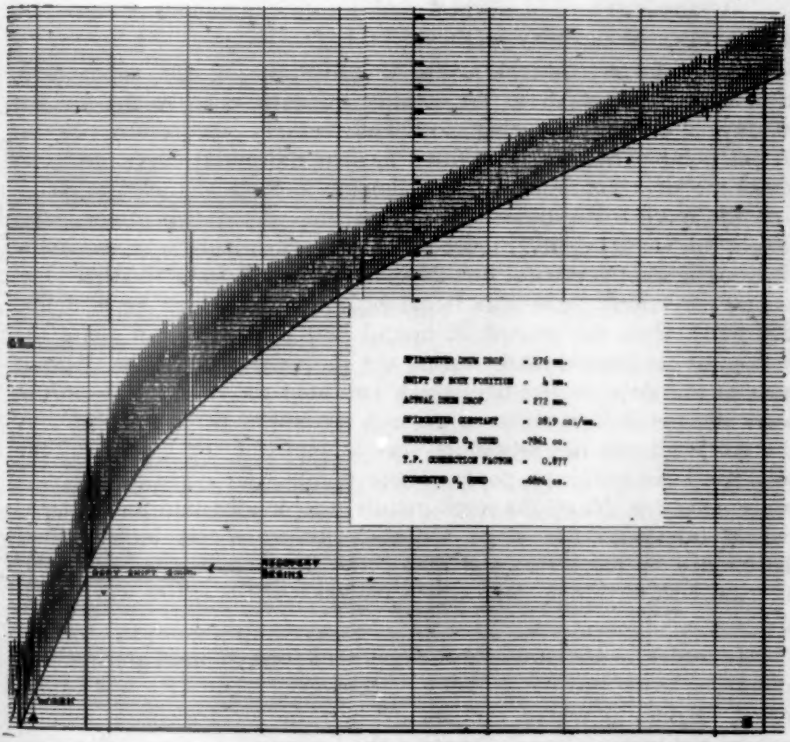

Fig. 1. A reproduction of a record used to show the method employed to measure the oxygen consumed during 1250 Kg.M. work and ten minutes' recovery.

tions and the second after the ten-minute ice application. The two experiments involving B.M.R. exactly paralleled one another.

4. *Oxygen consumption.*—Oxygen consumption was measured by use of a modified Benedict-Roth spirometer. Since it was required that oxygen consumed during work and recovery be measured, it was necessary to assemble the oxygen measuring unit in such proximity to the bicycle ergometer that oxygen could be breathed by the subjects while sitting on the bicycle.

The modified type spirometer provided a bell which held approximately 20 percent more oxygen than the clinical type. Although the large bell did not hold enough oxygen to meet the requirements of a subject during one minute of moderate work and ten minutes' recovery, one refilling during the experiment was sufficient.

Records of oxygen consumption were made by pen recording on an extension kymograph. Since the kymograph was turned by a constant speed motor at the rate of 29 mm. per minute, no timing devices were required.

A sample record of oxygen used during one minute of work and ten minutes of recovery is shown in Figure 1.

Since the oxygen tank had to be refilled during each experiment, a new base-line resulted. To simplify the calculation of the amount of oxygen consumed during work and recovery, the record was cut at the point of refilling and fitted against the initial curve, so as to make the slope continuous. The following method was used to calculate the oxygen consumed: A vertical line was drawn at the point where the work began (Figure 1). The work minute was set off by drawing a second vertical line 29 mms. (1 min.) from the first. Ten minutes' recovery time was found by drawing a third vertical line 290 mms. from the second. A line of best fit was drawn along the bottom of the record made during the recovery period. The unevenness of the slope of the line which indicated the drum drop during work did not lend itself to so gross a method of determination. For the work minute the procedure was to pinpoint the bottom of the tidal air lines on graph paper. These points were joined to form a continuous line. Next, the work minute was divided into four fifteen-second intervals. The slope for each fifteen-second interval was determined by inspection and then these slopes were combined geometrically to form one slope which represented the entire work minute.

In order to determine the amount of oxygen used during one minute of work and ten minutes of recovery, a base-line was established, beginning where the line of best fit for the work minute crossed the vertical line designating the beginning of the work (Figure 1, A), and extending horizontally for 319 mms. At this point (Figure 1, B) a vertical line was drawn perpendicular to the base-

line. The distance between B and C, the point where the vertical line crossed the line of best fit (Figure 1, C), represented the drum drop during one minute of work and ten minutes' recovery. By multiplying the drum drop in millimeters by the spirometer constant (28.9 for the spirometer used) the amount of uncorrected oxygen was determined. The value obtained was corrected to standard conditions.

It will be seen in Figure 1 that between the end of the work minute and the beginning of recovery there is a shift in the baseline. This is due to a shift in body position, and occurs consistently among subjects when changing from work to rest. In Figure 1 this amounted to 4 mms. Since this does not represent oxygen used, this figure was subtracted from the length of the line B-C before the uncorrected oxygen was determined.

If one is to show the effect of applying ice packs to the abdomen on the amount of oxygen required to perform work, the amount of work which the subjects do must be the same for all experimental conditions. Thus the first concern is a selection of a work level suitable to the subject.

There are numerous factors to be taken into account in selecting a work load. In the first place the work required must fall well within the capacity of the subjects, and yet be difficult enough to differentiate between small changes in oxygen requirement. The fact that the subject must breath into and out of a spirometer during exercise and recovery, requires that the work not be strenuous enough to demand more oxygen than can be delivered by the spirometer. It has been shown in this laboratory by Tuttle, *et al* (3) that 1250 Kg.M. on the bicycle ergometer meets the requirements satisfactorily.

5. *Arterial blood pressure and pulse rate.*—Systolic and diastolic blood pressures were measured by the use of a table model Baumanometer Type sphygmomanometer. The routine clinical procedure was followed. In order to establish resting blood pressures, readings were repeated at short intervals until there was agreement. The pulse was counted by the method of palpation from the radial artery. In establishing normal resting rates, the counts were taken for one minute. They were repeated until the same figure was obtained during several one-minute periods, with short intervals in between. Following work, thirty seconds were allowed before the beginning of the count. During this interval, blood pressure was taken. Beginning thirty seconds after the cessation of the work, the pulse was counted for thirty seconds every minute for ten minutes.

The procedure for the experiment in which oxygen consumption, pulse rate, and blood pressure were measured during 1250 Kg.M. of work and ten-minute recovery was established in the following manner: The subject rested in a supine position for fifteen min-

utes. He then walked approximately three steps and assumed a sitting position on the bicycle. He maintained this sitting position for the duration of the experiment. One minute after the sitting position was assumed the pulse and blood pressure were recorded. The nose clip and bit were then adjusted and the subject started breathing oxygen from the tank. Approximately one minute was allowed in order for the subject to accommodate to the apparatus and to assume his regular breathing pattern. At the word "go" he immediately pedaled the bicycle ergometer at a rate sufficient to place the recording needle on the four-volt line (4V = 1250 Kg.M. work) of the recording instrument chart. After exactly one minute of work the command "stop" was given, and a ten-minute recovery period followed immediately in which oxygen consumption was recorded and pulse and blood pressure were taken as previously described.

Ten subjects were used. Each subject was given a single trial on two consecutive days. One set of measures was made following fifteen minutes of bed rest; the other set was made following a comparable rest period during which ice was applied for the last ten minutes. Four subjects had ice applied the first day and were without ice the second day. The remaining six subjects had the experimental procedure reversed. This staggered procedure was adopted as a controlling device because individuals require less oxygen to perform a given amount of work when work on the bicycle is repeated from day to day. To further check the possibility that this increase in efficiency might obscure or augment the ice effects on oxygen consumption, three subjects, who completed their first run without ice and their second with ice, were re-run a third day without ice.

6. *Venous blood pressure.*—Venous blood pressure was measured by the direct method first described by Moritz and Tabora (4). The equipment consists of an L-tube 45 cm. long with a 5 cm. L. The end of the L is reduced in size and ground to fit a number 18 hypodermic needle. The bore of the tube is 5 mms. in diameter. This dimension is reduced to approximate the bore of the needle. The L-tube is washed with potassium oxalate, and sterilized along with the needle. In the process of sterilization, crystals of oxalate remain on the tube, and serve to prevent coagulation of the blood. The subject is placed in a supine position in close proximity to a table for handling the equipment. After the subject has rested for approximately 15 minutes, the needle is inserted into a superficial vein on the antecubital fossa in the right arm. As soon as the needle is properly placed, the L-tube is inserted. The right arm is supported at the approximate level of the heart. As soon as the blood ceases to rise in the tube, the height of the column of blood is measured and recorded as the normal venous pressure. Ice is then applied to the abdomen and the venous blood pressure measured at the end of thirty seconds,

sixty seconds after the application of ice, and then at one-minute intervals for nine minutes.

ANALYSIS OF DATA

1. *Maximum work output.*—Table I shows the mean difference in maximum work output between two consecutive one-minute trials on the bicycle ergometer when the trials are separated by a ten-minute rest period. During the control experiment the subjects merely rested in a supine position, while in the ice experiment, an ice pack was applied to the abdomen during this rest period. These data show that the mean work output of the second trial during ice application has a drop-off tendency which is decidedly less than that for the second trial during the control period. The mean difference

TABLE I

THE EFFECT OF ABDOMINAL ICE PACKS ON RECOVERY FROM FATIGUE

	Control			*Ice*		
	First Trial	*Second Trial*	*Difference*	*First Trial*	*Second Trial*	*Difference*
Mean (Kg.M.)	2987	2762	225	2930	2861	69
S.D.	161.6	207.8	127.0	137.2	200.8	96.1
t			5.578			2.268
Level of Confidence			0.1%			5.0%

For the control, the subjects were allowed a ten-minute rest between trials. To show the effects of ice, the abdominal ice pack was applied during a ten-minute rest period between trials. The data are the means of eleven cases.

TABLE II

THE EFFECT OF ABDOMINAL ICE PACKS ON RECOVERY FROM FATIGUE

Subjects	*Control Difference*	*Ice Difference*	*Difference*
1	181	102	79
2	334	116	218
3	72	— 15	87
4	334	146	188
5	355	12	343
6	189	157	32
7	416	234	92
8	203	178	25
9	79	25	54
10	301	—114	415
11	10	— 75	85
Mean Difference	225	69	147
S.D. Difference			123.9
t			3.75
Level of Confidence			1%

The data are based on the same figures as those in Table I. Here the individual differences are used to show the significance of the differences in maximum work output.

between the two trials when ice was used is 69 Kg.M. of work ($t = 2.27$), while the mean difference between the two trials when ice was not used (control) is 225 Kg.M. ($t = 5.58$). The loss in work output is much less when an ice pack is applied to the abdomen of the subject during the rest period between work periods than it is when the ice pack is omitted. This fact is statistically demonstrated in Table II, in which the distribution of differences for control data is paired with the distribution of differences with the ice data. These data also show that the drop-off in total work output is not as great when ice is applied as when it is omitted ($t = 3.75$). The individual data in Table II show that in three cases where ice was applied there is an increase rather than a decrease in work output during the second trial.

2. *Body temperature.*—The oral temperatures for ten subjects taken before and after a ten-minute abdominal application of ice are given in Table III. The temperatures show a mean drop after the application of ice of .46°F. This difference is significant at the 0.1 percent level of confidence.

TABLE III

THE EFFECT OF ABDOMINAL ICE PACKS ON ORAL TEMPERATURE

Subject	*Before Ice* (Degrees F.)	*After Ice* (Degrees F.)	*Difference* (Degrees F.)
1	98.6	98.0	0.6
2	98.1	97.6	0.5
3	98.4	97.9	0.5
4	98.4	98.1	0.3
5	98.5	97.7	0.8
6	98.3	98.1	0.2
7	98.8	98.4	0.4
8	98.0	97.8	0.2
9	98.5	97.9	0.6
10	98.6	98.1	0.5
Mean	98.42	97.96	0.46
S.D.	0.224	0.207	0.184
t			8.130
Level of Confidence			0.1%

The ice was applied after the normal temperature was determined, and was left for ten minutes. Immediately following the removal of the ice pack, the temperature was again recorded.

3. *Basal metabolic rate.*—Table IV shows a comparison of the paired B.M.R.s for all subjects during both control and abdominal ice packs. Referring to the control data, the mean difference between the first and second B.M.R.s is 1.0 Cal/sq.M./hr. This difference is not significant. Under the ice data, the first B.M.R. represents the control and the second shows the effect of ice. There

is a consistent reduction in the consumption of oxygen when the second B.M.R. is compared with the first. The mean difference is 5.7 Cal./sq.M./hr. This difference is significant at the 0.1 percent level of confidence.

4. *Oxygen consumption during work and ten minutes of re-*

TABLE IV

THE EFFECT OF ABDOMINAL ICE PACKS ON BASAL METABOLIC RATE

	Control			*Ice*		
Subjects	*First B.M.R.*	*Second B.M.R.*	*Difference*	*First B.M.R.*	*Second B.M.R.*	*Difference*
	C	C	C	C	C	C
1	37.5	41.9	—4.4	42.9	39.8	3.1
2	39.7	39.7	0.0	39.7	32.9	6.8
3	36.6	40.1	—3.5	37.6	35.2	2.4
4	32.9	32.9	0.0	48.6	40.6	8.0
5	35.1	36.2	—1.1	43.8	35.9	7.9
6	39.3	38.0	1.3	37.7	32.5	5.2
7	38.0	40.0	—2.0	39.4	33.9	5.5
8	42.3	41.5	0.8	37.8	31.5	6.3
9	38.8	38.1	0.7	39.1	31.6	7.5
10	36.8	38.2	—1.4	35.7	31.8	3.9
Mean	37.7	38.7	—1.0	40.3	34.6	5.7
S.D.	2.47	2.52	1.80	3.70	3.15	1.93
t			1.667			8.834
Level of Confidence			20.0%			0.1%

The control represents two consecutive B.M.R.'s with ten minutes of rest between. To show the effect of abdominal ice packs, they were applied during the ten-minute rest period in a similar experiment. The B.M.R.s are expressed in Cal/sq.M. surface area per hour.

TABLE V

THE EFFECT OF ABDOMINAL ICE PACKS ON THE AMOUNT OF OXYGEN REQUIRED TO PERFORM 1250 KG.M. WORK AND TEN MINUTES' RECOVERY

Subjects	*Control*	*Ice*	*Difference*
	c.c.O_2	c.c.O_2	c.c.O_2
1	6156	5867	289
2	7107	6687	420
3	6108	5462	646
4	5526	5327	199
5	6485	5867	618
6	6314	6048	266
7	5793	5404	389
8	6624	5950	674
9	5780	5607	173
10	6355	5468	887
Mean	6225	5769	456
S.D.	455.34	388.87	226.17
t			6.048
Level of Confidence			0.1%

covery.—The data in Table V show the amount of oxygen consumed for both ice and control groups during one minute of work and ten minutes of recovery. All subjects rested fifteen minutes before work. In order to show the effect of the abdominal ice pack on the oxygen consumed during the one minute of work and the ten minutes of recovery, a parallel experiment was carried out on the same subjects. The ice was applied during the last ten minutes of the rest period. The data show that in every case the oxygen required to perform 1250 Kg.M. work was less when the ice pack was applied than when they rested without it. This difference was maintained regardless of whether the ice pack or the control experiment was performed first. The mean difference between the control and ice experiment is significant at the 0.1 percent level of confidence.

In the experimental procedure the subjects were staggered to prevent a learning or training factor from influencing the results. To this end it seemed wise to re-run three subjects who had had a control run on the first day and ice, the second. An additional control record was taken on the third day for these three subjects. The oxygen consumption for this record remained above that for the ice record the day before, but below the first control record. The actual figures in cubic centimeters of oxygen consumed for each of these three cases are tabulated below according to consecutive recordings.

	First Recording	*Second Recording*	*Third Recording*
	Control	Ice	Control
	6156	5867	6020
	7170	6687	6943
	6483	5867	6340
M.	6583	6140	6434

This is evidence that the ice variable had a greater effect than either the learning or training factor.

5. *Diastolic and systolic pressure during rest.*—Table VI shows the effect of the abdominal ice pack on diastolic pressure taken on ten subjects at rest. Diastolic pressure in every subject, to which the ice was applied, showed a consistent rise above the resting level. This difference between the diastolic blood pressure at rest without the ice pack and that after the application of the ice pack for ten minutes is significant at the 0.1 percent level of confidence. This difference is shown graphically in Figure 2.

The effect of the abdominal ice pack on resting systolic pressure is also shown in Table VI. The data show that the mean difference between resting systolic pressure without the ice and with it is 2.7 mm. Hg. This small difference falls within the limits of error in taking blood pressure by the method employed. Since this small

difference is only significant at the 10 percent level of confidence it is doubtful that a true difference exists.

TABLE VI

THE EFFECT OF ABDOMINAL ICE PACKS ON RESTING DIASTOLIC AND SYSTOLIC BLOOD PRESSURE

	Diastolic			*Systolic*		
Subject	*Before Ice*	*After Ice*	*Difference*	*Before Ice*	*After Ice*	*Difference*
	mm.Hg.	mm.Hg.		mm.Hg.	mm.Hg.	
1	92	100	— 8	134	130	4
2	84	95	—11	115	117	— 2
3	92	97	— 5	128	130	— 2
4	88	98	—10	120	130	—10
5	80	89	— 9	100	112	—12
6	84	102	—18	124	132	— 8
7	68	84	—16	108	110	— 2
8	74	80	— 6	108	108	0
9	87	96	— 9	127	124	3
10	70	86	—16	120	118	2
Mean	81.9	92.7	—10.8	118.4	121.1	— 2.7
S.D.	8.228	7.064	4.214	10.070	8.769	4.226
t			7.689			1.916
Level of Confidence			0.1%			10.0%

After the normal blood pressures were taken the ice pack was applied for ten minutes. Blood pressure recordings were taken during the last minute of the application of ice.

6. *Diastolic and systolic pressures before work and during ten minutes' recovery.*—The effect of the abdominal ice pack on the recovery of diastolic blood pressure is shown in Table VII. Here, two parallel experiments were conducted; in one the subject simply rested for fifteen minutes before the 1250 Kg.M. work period, and in the other the abdominal ice pack was applied during the last ten minutes of the fifteen-minute rest period. These data show that the

TABLE VII

THE EFFECT OF ABDOMINAL ICE PACKS ON THE RECOVERY OF DIASTOLIC BLOOD PRESSURE AFTER 1250 KG.M. WORK

Condition	*Control Means* mm.Hg.	*Ice Means* mm.Hg.	*Difference*	*S.D.*	*t*	*Level of Confidence*
Rest on Bicycle	79.5	84.0	4.5	6.828	2.131	10%
		Recovery After Work				
2nd min.	89.5	92.4	2.9	14.254	.451	70%
4th min.	80.9	89.3	8.4	9.177	2.894	2%
6th min.	79.1	87.9	8.8	5.263	5.288	0.1%
8th min.	81.1	89.0	7.9	6.156	4.058	1%
10th min.	81.1	88.6	7.5	7.912	2.997	2%

application of ice caused an increase in resting diastolic pressure while the subject was sitting. When the data are compared, the diastolic pressure is significantly higher after the application of ice during the entire recovery period except during the second minute.

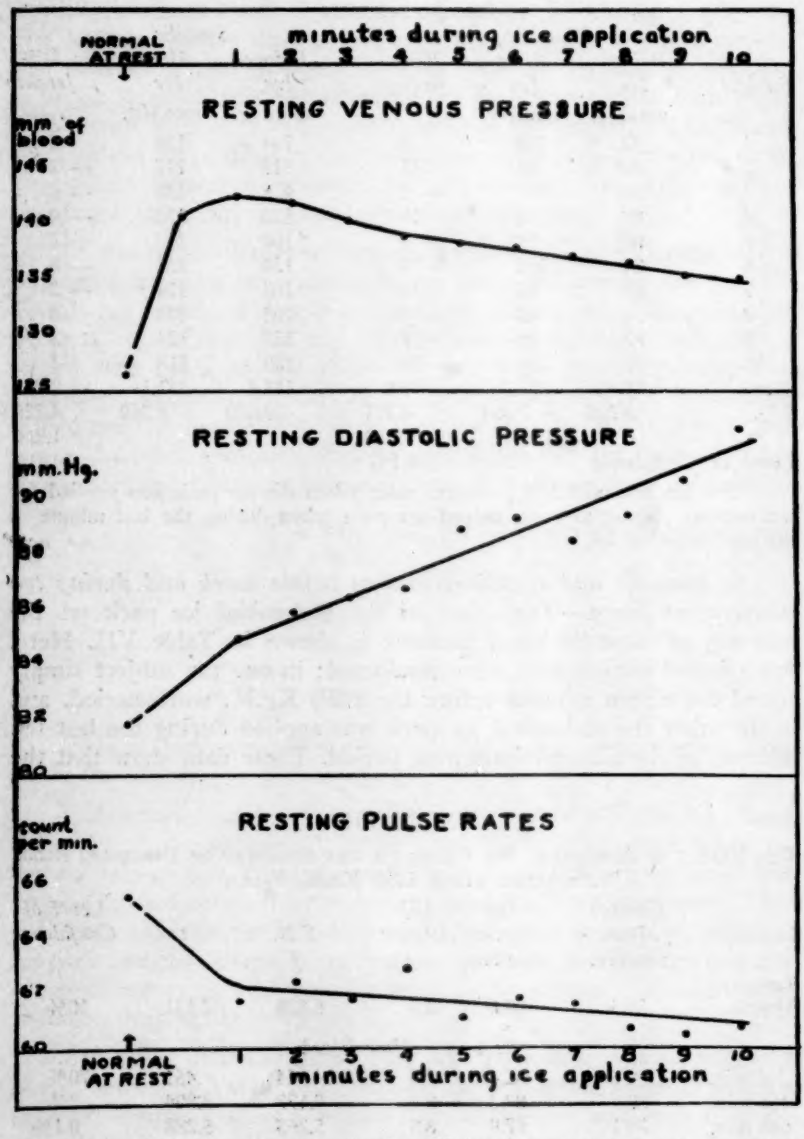

Fig. 2. The effect of the application of the abdominal ice pack on resting venous pressure, diastolic pressure, and pulse rate.

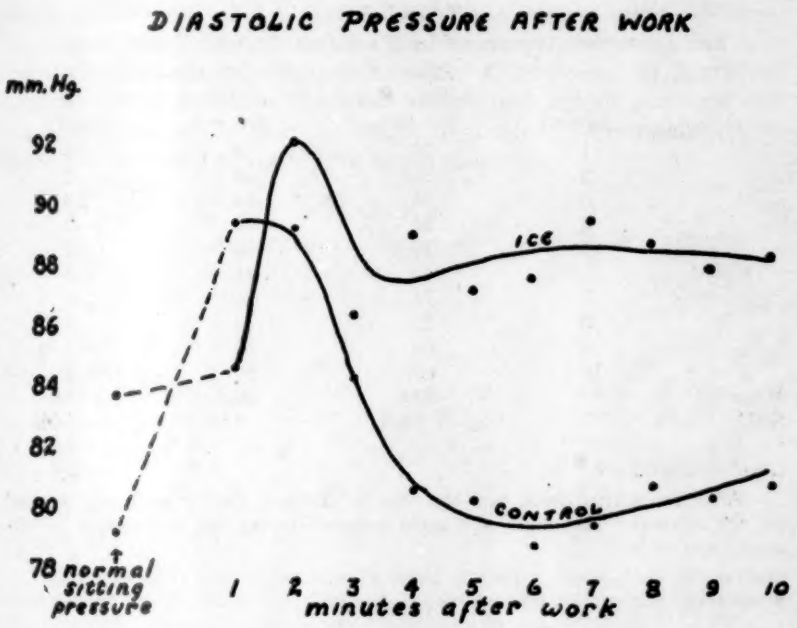

Fig. 3. The effect of the abdominal ice pack on the recovery of diastolic blood pressure after 1250 Kg.M. work.

The same comparison described above is shown graphically in Figure 3.

Since the application of the ice pack did not significantly affect the recovery of the systolic blood pressure after 1250 Kg.M. work, a summary table is not included.

7. *Pulse rate during rest.*—Table VIII shows the effect of the abdominal ice pack on the pulse rates of ten subjects at rest. The data show that in all cases except one the pulse rate decreased to a point below the resting normal level when ice was applied. The difference between the pulse rates at rest without the the ice pack and those after the ten-minute application of ice is significant at the 2 percent level of confidence. Thes differences are shown graphically in Figure 2.

8. *Pulse rates before work and during ten minutes' recovery.*—Table IX shows a summary of the effect of the abdominal ice pack on the pulse rate of eleven subjects before work and during ten minutes' recovery. Here also, two like experiments were carried out, one in which the subject rested before the 1250 Kg.M. work, and the other in which the abdominal ice pack was applied during

TABLE VIII

THE EFFECT OF ABDOMINAL ICE PACKS ON RESTING PULSE RATES

Subject	*After 15 Min. Rest per min.*	*After 10 Min. Ice Application per min.*	*Difference*
1	70	56	14
2	56	58	— 2
3	74	64	10
4	84	82	2
5	54	52	2
6	64	56	8
7	74	66	8
8	52	50	2
9	66	64	2
10	62	60	2
Mean	65.6	60.8	4.8
S.D.	9.625	8.635	4.665
t			3.087
Level of Confidence			2%

After the normal pulse rate had been established, the ice pack was applied for ten minutes. The pulse was again counted during the last minute of the application of ice.

TABLE IX

THE EFFECT OF ABDOMINAL ICE PACKS ON THE RECOVERY OF THE PULSE AFTER 1250 KG.M. WORK

Condition	*Control Means*	*Ice Means*	*Difference*	*S.D.*	*t*	*Level of Confidence*
Rest on Bicycle	72.0	68.2	3.8	6.688	1.720	20%
			Recovery After Work			
1 min.	96.0	92.7	3.3	7.399	1.410	20%
2 min.	77.1	73.5	3.6	7.072	1.610	20%
4 min.	72.0	67.5	4.5	5.869	2.479	5%
6 min.	73.5	68.7	4.8	5.412	2.747	5%
8 min.	72.5	70.7	1.8	4.549	1.251	30%
10 min.	73.8	71.8	2.0	3.814	1.658	20%

the last ten minutes of the fifteen-minute rest period. When the data are compared interval by interval as shown in Table IX, the tendency is for the pulse to be less after the application of ice. However, the differences are not significant except during the fourth and sixth minutes.

9. *Venous pressure.*—In Table X normal venous blood pressure is compared with the venous pressure after the application of the abdominal ice pack. The venous pressure is recorded in mm. of blood read directly from the L-tube. These data show a sharp increase in venous pressures within thirty seconds after the application of the ice pack (Figure 2). The crest of the increase was reached in most

cases at the end of the first minute. One subject required three minutes to reach this crest. After this maximum was reached it was maintained for one or two minutes, but was followed by a gradual decrease. The differences between the normal venous pressure and the pressures at the intervals noted in Table X are significant at the 1 percent level of confidence in all instances.

TABLE X

THE EFFECT OF ABDOMINAL ICE PACKS ON VENOUS BLOOD PRESSURE

Time	*Mean mm. Blood*	*Difference mm. Blood*	*S.D.*	*t*	*Level of Confidence*
Resting (Normal)	126.6				
Resting and Ice					
30 sec.	141.2	—14.6	9.238	4.470	1%
1 min.	142.8	—16.2	10.282	4.457	1%
2 min.	142.4	—15.8	9.724	4.607	1%
4 min.	139.3	—12.7	9.126	3.939	1%
6 min.	138.1	—11.5	8.112	4.010	1%
8 min.	136.7	—10.1	7.549	3.784	1%
10 min.	135.3	— 8.7	7.115	3.392	1%

The normal is the resting venous blood pressure. As soon as the normal was established, the ice was applied and left in place throughout the experiment. The data are the means of nine cases expressed in mm. of blood.

10. *Sand effects.*—In order to determine if some of the above changes were the result of the weight of the ice applied to the abdomen, a series of experiments parallel to the resting diastolic, systolic, and pulse rate experiments was performed in which a sand bag was substituted for the ice pack. Five subjects were used in these experiments. The weight and the distribution of the weight of the sand bag were approximately that of the ice pack. It is of interest to note that the diastolic blood pressure decreased from a mean of 68.8 mm.Hg. after the fifteen minutes of rest to 65.6 mm.Hg. after ten minutes of application of sand. Figure 2 indicates that application of ice produces the opposite effect, i.e., a rise in diastolic pressure. The same reversal of data occurs with systolic pressure readings. Pulse rates show a slight average increase between the end of the fifteen-minute rest period and the tenth minute of sand application (64.8-65.6). Comparable data for the application of ice show the reverse, a decrease in pulse rates from 65.6 to 60.8 (Table VIII). It is evident from these comparisons that the changes attributed to ice application are not due to the weight of the ice. In fact, the weight, *per se* is acting counter to the effects of cold.

DISCUSSION

The consistency with which abdominal ice packs alleviated fatigue produced by short bouts of strenuous exercise may raise the question as to whether this effect is due to physiologic changes, or

whether purely a psychologic reaction? It is true that there was no way to camouflage the experiment. At any rate, whether the ice packs operated through either physiologic or psychologic mechanisms, the result leads to the conclusion that it is effective therapy to use them.

A further study of the effect of the abdominal ice packs on physiologic mechanisms is evidence that at least a large part of the alleviation of fatigue is physiologic in origin. Just how the cooling effect operates is a question. Were it not for the fact that the systolic blood pressure is not affected significantly, the result might be accounted for as an adrenalin reaction. The fact that some subjects actually did more work (Table II) leads one to believe that there is some psychologic effect. The effects produced by the abdominal ice packs on venous and diastolic blood pressure suggest that there occurs a significant increase in vasomotor tone in the abdominal blood vessels. The tendency toward a decrease in heart rate might explain the lack of systolic effect.

The control of shivering was found to be important in the studies involving oxygen consumption measurements. When it occurred, the experiment was terminated immediately since the shivering effects tended to submerge the cold effects. Shivering was controlled by covering the subjects so that peripheral stimulation due to air current was prevented. When subjects were protected by cover, they seldom shivered.

It will be remembered that there was a significant fall in B.M.R. due to the application of the abdominal ice pack. A part of this fall can be accounted for by the fact that there was a decrease in body temperature. However, since only a part of this decrease in B.M.R. can be accounted for by the decrease in body temperature (7 percent per degree temperature change), there remains an appreciable decrease in B.M.R. which can be attributed only to the cooling effects.

It is of interest to note that in the experiment involving maximum work output, there was ample evidence to show that the application of abdominal ice packs alleviates dizziness, nausea, etc., resulting from bouts of strenuous exercise. In addition, there is some indication that a carry-over effect of the ice application tends to increase work output on the following day.

CONCLUSIONS

On the basis of data collected relative to the effect of abdominal ice packs on recovery from fatigue and on some of the physiologic responses involved in recovery from fatigue, the following conclusions seem justified:

1. Recovery from fatigue resulting from strenuous exercise is facilitated by the application of abdominal ice packs.

2. The application of an ice pack causes a decrease in basal metabolic rate. Although, under the same circumstances, there is a decrease in body temperature, the magnitude of this decrease is not sufficient to account for all of the decrease in metabolic rate.

3. The amount of oxygen required to perform a given amount of moderate work is decreased by the use of the abdominal ice pack.

4. The application of ice to the abdomen causes an increase both in resting diastolic and venous blood pressures. Under the same circumstances, resting systolic blood pressure shows no significant change.

5. Diastolic pressure during recovery after a bout of moderate exercise remains significantly higher when ice is applied before the work than when rest alone precedes the work. Under these conditions, systolic pressure shows no significant change.

6. The resting pulse rate becomes significantly less as a result of the application of the abdominal ice pack. The pulse rate during recovery from a bout of moderate exercise tends to become less when ice is applied before the work than when rest alone precedes the work. These differences are significant only during the fourth to the sixth minutes of recovery.

7. The weight of the ice does not account for the changes resulting from the application of the ice pack.

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Achievement Scale Scores for High School Swimming

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ACHIEVEMENT scales have considerable value for the high school physical education teacher provided they are based upon actual performance of students. A good test aids the instructor in evaluating his pupil's performance, and at the same time motivates the student to acquire more skills and facility.

Five years ago the writer devised a set of wartime swimming achievement scales for use above the high school level (3). The scales were extensively used by colleges and by various training stations of the armed services to determine whether or not men were aquatically fit to meet wartime emergencies. Because the scales were constructed primarily for college men and were geared to war conditions, these tests were not highly suitable for boys and girls of high school age. This conclusion is the outgrowth of numerous requests received from physical education teachers in high schools during the past few years. Achievement scale scores for swimming at the college level for men have since been revised to meet postwar objectives (4).

PURPOSE OF THE SCALE SCORE IN THIS STUDY

One problem confronting the swimming instructor at the outset of each school year is the classification of his students. A wealth of valuable time is devoted to attempted appraisal of students' abilities without the aid of objective tests. It would prove far more efficient to employ an achievement scoring system which segregated all the students into a number of capability groups. For example, if grades running from 0 to 100 are employed with reference to the student's performance of a particular feat, not only the instructor but the student will readily comprehend the estimate of his ability since it is on the same basis as his academic grades.

An achievement scale scoring system may be used not only to segregate pupils at the outset of the training period, but serves as an equally good means of measuring the degree of improvement at the end of the term. Too often, in grading a student, instructors have to depend upon such purely subjective qualities as the pupil's attitude and effort and upon general impressions of his original and final skill. How much more satisfactory to both the teacher and student would be the adoption of an objective yardstick! An achievement score would serve as a strong motivating force for them both,

particularly if a visible progress chart were available all during the training period. Furthermore, the objective record would constantly remind the instructor which pupils needed particular encouragement and supervision. It would show him also the degree of success of his teaching methods.

It is with the dual aim of increasing the pleasure and efficiency of swimming instruction that the following scale scores were worked out, and the practical results of their application presented. Although the tests are of admittedly preliminary nature, it is hoped that the wider application of the principles involved will lead to an eventual change in swimming instruction which will place it in a more scientific position than it now holds.

THE TESTS

Six high schools in the San Francisco Bay area volunteered to cooperate in setting up and administering swimming scale tests. Each school had a swimming pool and gave instruction to both boys and girls. The instructors agreed that it would be well to select for the experiment the fundamental strokes taken from the program, as represented by the crawl, the flutter kick, the elmentary back stroke, the side stroke, the breast stroke, and an endurance swim. These events could all be adapted to objective measurement and scoring.

The separate tests given to both boys and girls are listed below:

1. Time in tenth-seconds for the 25-yard flutter kick while holding a regulation water polo ball.
2. Time in tenth-seconds for the 50-yard crawl.
3. Minimum number of strokes required for the 25-yard elementary back stroke.
4. Minimum number of strokes required for the 25-yard side stroke.
5. Minimum number of strokes required for the 25-yard breast stroke.
6. 10-minute endurance swim—number of yards.*

Each school was supplied with printed instructions for carrying out the capability tests of students with regard to each of the above events. The school was also given lined mineographed score sheets for designating the quality of performance of each student. Each school provided its own tenth-second stopwatch as well as a regulation water polo ball.

Tests were run during the spring of 1947. Participating in the studies were high schools in Berkeley, Daly City, Burlingame, San Mateo, Redwood City, and Palo Alto. There were 1,093 individual students in the group tested, 647 of this number being girls.

* Test scores for the endurance swim were secured in one school only.

FINDINGS

Critical ratios were computed from the mean and standard deviation to learn if significant differences existed between the data for boys and those for girls.

When comparing the scores made by boys with those listed for girls on the six swimming tests, CR's were all above 2.58 except in one instance, the 25-yard side stroke. If CR is 2.58 or more at the .01 level of significance, the null hypothesis can be rejected with great confidence as in 99 out of 100 trials there will always be a difference greater than zero (2). The CR of the side stroke was 2.28 which may be considered significant as in 97 chances out of 100 there will always be a difference found between the boys and the girls. Since all of the tests for boys and girls showed a high degree of difference, separate scales were made for each group (Table I).

TABLE I

CRITICAL RATIOS, BOYS VS. GIRLS SWIMMING TESTS

Event		*Cases*	*Mean*	σ	σ_M	*CR*
Time for the 50-yard-crawl	Girls	396	51.40	12.64	.64	10.10
	Boys	446	43.52	10.5	.45	
Time for the 25-Yd. Flutter Kick	Girls	647	42	11.45	.45	4.09
	Boys	318	38.52	13.08	.73	
25-Yd. Elem. Back, Number of Strokes	Girls	569	14.74	6.26	.26	4.27
	Boys	255	17	7.20	.46	
25-Yd. Side Stroke, Number of Strokes	Girls	532	14.36	5.06	.22	2.28
	Boys	381	16	4.15	.21	
25-Yd. Breast Stroke, Number of Strokes	Girls	469	14.10	5.11	.24	4.60
	Boys	358	15.94	6	.32	

When plotting raw scores of the different swimming activities for both boys and girls in high school, distributions were generally negatively skewed with the curve tailing off toward the lower end. Standard scale scores were not computed because the distributions were not normal. Instead all raw scores were put into a cumulative frequency distribution and percentages ascertained. These percentages were then plotted, the curve smoothed where minor fluctuations existed and percentile norms ascertained in terms of a smoothed ogive. The scores range from 0 to 99 (Table II and III).

One plausible explanation to account for this negative skewness in swimming activities for the high school (a high percentage of poor performers) is that swimming is not a skill to which all children have been exposed for equal time intervals, and hence there will result more variations from the normal than might be noted for such physical activities as walking, running, and throwing.

By increasing the number of cases and widening the sampling

area to schools in other localities, sufficient groups of varying abilities to more nearly normalize the distributions might be provided.

RELIABILITY

A random sampling of 124 boys was given the five mentioned tests on separate days of one week and the same tests repeated the following week without any intervening instruction to determine reliability. Pearson product moment r for the elementary back stroke was $r = .96 \mp .04$; the side stroke, $r = .90 \mp .01$; the breast stroke, $r = .93 \mp .01$; the 50-yard crawl, $r = .92 \mp .03$; and the 25-yard flutter kick, $r = .89 \mp .02$. These measures of correspondence show a high degree of reliability.

VALIDITY

In the absence of an independent external criterion of swimming ability, the best substitute seemed to be the total test battery score. This is a commonly used test construction procedure. By totaling the raw scores made on the six tests (measurable aspects of the high school swimming program) and labeling this total score the criterion (all around high school swimming ability), correlations were obtained between each event and the total score. The product moments r are given in Table IV.

These six events possessed the following factors: speed (50-yard crawl and 25-yard flutter kick for time), endurance (a ten-minute swim), skill and technique of swimming each event plus glide and relaxation ability (number of strokes required to swim 25-yard elementary back stroke, side stroke, and breast stroke). In the correlations in Table IV all cases show a significant degree of relationship with the criterion (total scores). Since the 10-minute endurance swim requires the most time to administer, and because of the fact that it correlated highest with the side stroke ($r = .90$) and lowest with the criterion ($r = .59$), it was decided to eliminate endurance swimming from the final battery.

Because of the apparent relationship of flutter kicking to swimming the 50-yard crawl and the fact that the side stroke and the elementary back stroke had the highest correlation with the criterion. these events were intercorrelated to see if they measured the same factors. The 50-yard crawl with the 25-yard flutter kick showed a r of $.63 \mp .02$, and the 25-yard elementary back stroke with the side stroke for the same distance an r of $.63 \mp .03$. These correlations, though significant, are low enough to indicate that each event contributes somewhat to the total score or criterion and, therefore, if time permits, should be included in the final test battery.

If conditions are such that time is an important factor the side stroke by itself (side stroke with the criterion $r = .94 \mp .004$) could be used as a single best measure of the criterion.

In order to determine probable relationships between the cri-

TABLE II

ACHIEVEMENT SCORES FOR HIGH SCHOOL SWIMMING — BOYS

Percentiles	25-Yd. Flutter Kick With Polo Ball	50-Yd. Crawl	Glide & Relaxation Ability. No. of Strokes for 25 Yds.		
	Seconds	Seconds	Elem. Back	Side	Breast
100					
99	8-9	26	4	4	4
98	10-13	27	5	5	5
97	14-15		6	6	6
96	16	28		7	
95	17		7	8	
94	18	29			7
93	19				
92	20		8		
91	21				
90		30		9	8
89	22				
88					
87					
86	23	31			
85			9		9
84				10	
83	24	32			
82					
81					
80	25	33	10		
79					10
78	26				
77					
76				11	
75		34			
74	27		11		
73					
72					11
71					
70	28				
69					
68	29				
67		35			
66					
65					
64	30			12	12
63		36	12		
62	31				
61					

Percentiles	25-Yd. Flutter Kick With Polo Ball	50-Yd. Crawl	Glide & Relaxation Ability. No. of Strokes for 25 Yds.		
	Seconds	Seconds	Elem. Back	Side	Breast
60					
59	32				
58		37			
57			13		
56					13
55		38		13	
54	33				
53					
52		39			
51			14		
50					
49	34				14
48					
47	35	40		14	
46					
45			15		
44					
43					
42		41			15
41	36				
40		42		15	
39					
38					
37	37		16		
36		43			16
35	38				
34			17	16	
33	39				
32		44			
31	40				
30					17
29	41				
28			18	17	
27	42	45			
26					
25	43	46			18
24				18	
23	44		19		
22	45	47		19	
21					

Percentiles	25-Yd. Flutter Kick With Polo Ball	50-Yd. Crawl	Glide & Relaxation Ability. No. of Strokes for 25 Yds.		
	Seconds	Seconds	Elem. Back	Side	Breast
20	46	48			19
19	47				
18	48	49	20		
17			21	20	20
16	49		22		
15	50		23		
14	51	50	24	21	21
13		51			
12	52	52		22	22
11	53		25		
10	54	53			23
9	55	54	26	23	
8	56	55	27	24	24
7	57	56	28	25	25
6	58-59	57	29	26	26
5	60-61	58		27	27
4	62-65	59	30	28	28
3	66-68	60-61	31-32	29	29
2	69-71	62-65	34-35	30	30-32
1.8	72	66	36-38	31	33-35
1.6	73				36-37
1.4	74	67			38-39
1.2	75				40-42
1.0	76	68	39	32-33	43
.8	77-79	69	40-45	34-35	44
.6	80-81	70-73	46-49	36-39	45-46
.4	82-85	74-79	50-58	40-45	47-50
.2	86-89	80	59	46-49	51-58
.1	90	81	60	50	59

terion or score given by judges as to the student's gliding and resting ability and the number of actual strokes required for a 50-yard swim, correlations were made for the elementary back stroke, the side stroke, and the breast stroke. Three judges stood on opposite sides of the pool and counted the approximate seconds each swimmer could hold the glide. For example, if a student could hold the glide 8 counts, he was given a score of 8, and so forth. Counts were made for three complete strokes and the score averaged. This score then was correlated with the total number of strokes required to cover the 50 yards. Pearson product moment r for the elementary back stroke was $r = .90 \mp .08$, the side stroke, $r = .86 \mp .02$, and the breast stroke, $r = .91 \mp .03$. Three swimming experts also graded the swimmer's form on the three mentioned strokes from 0 to 10 (10 being perfect) and the total number of strokes required for the 50-yard swim. For the elementary back r was $.92 \mp .01$, the side stroke, $r = .99 \mp .007$, and the breast stroke, $r = .93 \mp .03$.

SUMMARY

Achievement scale scores in swimming for boys and girls in high school are the results obtained from testing 1,093 students in six high schools of the bay area.

Events selected were those recommended by high school swimming instructors as fundamental skills in their aquatic program. The tests given follow:

TABLE III

ACHIEVEMENT SCALE SCORES FOR HIGH SCHOOL SWIMMING — GIRLS

Percentiles	25-Yd. Flutter Kick With Polo Ball	50-Yd. Crawl	Glide & Relaxation Ability. No. of Strokes for 25 Yds.		
	Seconds	Seconds	Elem. Back	Side	Breast
100					
99	16-18	29-31	5	5	5
98	19-21	32-34	6	6	6
97	22-24	35-36		7	
96	25			8	7
95		37	7		
94	26	38			
93					
92		39			
91	27				
90		40			
89					8
88	28				
87		41		9	
86			8		
85	29				
84		42			
83					9
82					
81		43			
80	30	44		10	
79					
78					
77					
76					
75		45			
74	31				
73					
72			9		
71					
70	32	46		11	10
69					
68			10		
67					
66	33	47			
65					
64	34				
63					
62	35				
61		48			

Percentiles	25-Yd. Flutter Kick With Polo Ball	50-Yd. Crawl	Glide & Relaxation Ability. No. of Strokes for 25 Yds.		
	Seconds	Seconds	Elem. Back	Side	Breast
60			11	12	
59					
58	36	49			11
57					
56					
55					
54	37	50	12		
53					
52					
51	38	51			
50		52		13	
49	39				
48					
47		53			12
46	40		13		
45					
44			14		
43		54			
42	41				
41		55			
40	42		15	14	
39					
38					13
37	43	56			
36					
35					
34	44		16		
33	45	57			
32		58		15	14
31					
30	46	59	17		
29				16	
28		60	18		
27	47				
26		61			
25	48				15
24	49	62	19		
23					
22	50			17	16
21	51	63			

Percentiles	25-Yd. Flutter Kick With Polo Ball	50-Yd. Crawl	Glide & Relaxation Ability. No. of Strokes for 25 Yds.		
	Seconds	Seconds	Elem. Back	Side	Breast
20		64	20	18	
19	52				
18	53-54	65			
17	55	66	21		17
16	56		22		18
15	57	67			
14	58	68		19	19
13	59	69	23		
12	62	70		20	
11	63-64	71	24		
10	65-66	72		21	20
9	67-70	73			21
8	71-74	74	25		22
7	75-78	75	26	22	
6	79-82	76-77	27	23	23
5	83-86	78	28		24
4	87-89	79-80	29	24	25
3	90-96	81-83	30	25-26	
2	97	84-87	31	27	26-27
1.8	98	88	32	28	28
1.6	99	89	33		
1.4	100-103	90	34	29	
1.2	104-106	91-92	35	30	
1.0	107-109	93-94	36	31	29
.8	110-114	95-96		32	30
.6	115-117	97	37	33	31
.4	118-120	98	38	34	32
.2	121-123	99	39	35	
.1	124	100	40	36	33

1. Time for the 25-yard flutter kick with polo ball.
2. Time for the 50-yard crawl stroke.
3. Number of strokes required to swim 25-yard elementary back stroke.
4. Number of strokes required to swim 25-yard side stroke.
5. Number of strokes required to swim 25-yard breast stroke.
6. Number of yards achieved for the 10-minute endurance swim.

It was found when compiling critical ratios that significant differences existed when comparing the data for boys and girls necessitating separate scale scores for each.

The majority of the distributions were negatively skewed and because of this abnormality, raw scores were put into a cumulative frequency distribution and percentages determined. These percentages scores were then plotted in terms of a smoothed ogive and the scale scores ascertained. They range from 0 to 99.

Reliability was determined by repeating the test without intervening instruction and product moment r for the retest follows: elementary back, .96 $\mp$ .04; side stroke, .90 $\mp$ .01; breast stroke, .93 $\mp$ .01; 50-yard crawl stroke, .92 $\mp$ .03; and the 25-yard flutter kick, .89 $\mp$ .02.

The total raw battery test score was used as the criterion in absence of a reliable standardized test. Each event was then correlated

TABLE IV

CORRELATION OF TOTAL SWIMMING ABILITY WITH INDIVIDUAL EVENTS

	50-Yd. Crawl Time	25-Yd. Flutter Kick Time	10-Min. Endurance Swim	Number of Strokes Required for: 25-Yd. Elem. Back	25-Yd. Side Stroke	25-Yd. Breast Stroke
Total of Swimming Scores (6 Tests)	$r = .65 \mp .02$	$.604 \mp .03$	$.59 \mp .01$	$.88 \mp .01$	$.94 \mp .004$	$.77 \mp .03$

with the criterion and validity established. The 10-minute endurance swim correlated lowest with the criterion and because it required the most time to administer was eliminated from the final battery. On the other hand, the side stroke correlated highest with the criterion, r of $.94 \mp .004$, and if time is an important factor it can be used as the best single measure of high school swimming ability.

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PROCEDURE FOR HIGH SCHOOL SWIMMING ACHIEVEMENT TESTS

The following test should be given to all students who can swim.

1. *50-Yard Crawl for time.*—Use a racing dive. Swim the crawl stroke for 50 yards. Time students with a stop watch. Scoring: Record in tenth seconds, e.g., 28.4.

2. *25-Yard Flutter Kick for time with polo ball.*—Start in the pool holding onto the gutter with one hand and other hand to ball. Start with the word "go." Use a regulation push off. Stop when ball touches end. Scoring: Record time in tenth seconds, e.g., 26.8.

3. *Glide and Relaxation Ability for 25 Yards for the Elementary Back Stroke, Side Stroke and Breast Stroke.*—Only one leg action and one arm action allowed per stroke.

A. Elementary Back Stroke: Start in the water using a regulation push-off at the start with arms at sides of body and legs together. Use frog kick. Arms must remain in the water at all times, but they may be raised above the shoulders on the recovery. Recommend maximum glide. No arm or leg action allowed on the push-off. Scoring: Record push-off plus number of strokes as total strokes.

B. Side Stroke: Start in water using regulation push-off for start and for turn. Push-off into gliding position with lower arm extended over the head and upper arm along side of the hip. No arm or leg action allowed on the push-off. Only one leg action allowed per arm action while stroking. Use single under-arm or underwater side stroke and not the over-arm side stroke. Scoring: Record push-off plus strokes used as total strokes.

C. Breast Stroke: Start in water using regulation above water push-off for start and for turn. Push-off into gliding position with arms extended over head and legs together. No arm pull or leg kick allowed on push-off's. Use regulation breast stroke. No butterfly. Only one arm and leg action allowed per stroke. Scoring: Count push-off plus number of strokes as total strokes.

After the test has been explained, students can count their own strokes. If the pool is not large enough for the entire class, divide into two sections and have the students on the bank count the strokes. It saves time to record results of the whole class. Give each student a number from 1 to 50.

A Study of the Degree of Transfer Between Quickening Exercises and Other Coordinated Movements

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(Submitted for publication, May, 1948)

INTRODUCTION

QUICKENING exercises are frequently used in physical education on the basis of the assumption that their effect will transfer and result in the speeding up of other types of movements. Review of the physical education literature fails to show any investigation of this problem, although it would seem to be of considerable importance.

Psychologists have found that transfer effects in motor skills tend to be highly specific. Typical conclusions are as follows: Perrin (15) says that skills are specific; Jones (8), that fine motor reactions are specialized; Seashore (17, 18), that there is no overall or general positive dependence or interrelatedness of fine motor abilities and gross motor abilities; the evidence points toward a theory of high specificity and against the hypothesis that there is a group of basic motor skills; Hollingworth (7), that there is no general ability; Muscio (12), that intercorrelations between motor tests are not significant; Harrison and Dorcus (6), that there is no unitary speed trait characteristic of motor movements; Pacaud (14), that it is misleading to speak of an individual's general reaction time, nor is it satisfactory to accept the reaction time of one group of movements as a general motor characteristic of an individual.

Lanier (10) states that the amount of correlation between measurements of speed of reaction depends upon the similarity of the movements; the more similarity, the greater the agreement. Seashore (16) found that ratings on amounts of previous training in athletics, instrumental music, typing, and other motor skills tend to show that these types of training do not have very great carry-over effects to the performance tested, but there may be certain rather specific transfer effects.

Woodword (21) recently did an experiment on the transfer of

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training in motor learning. Identical movements were required to assemble a loom and a safety switch. There was a significant transfer resulting in faster assembly of the safety switch due to experience in assembly of the loom.

Burley (2) and Keller (9) found that among groups of athletes, baseball players had the fastest reaction time and speed of movement. This raises the question as to whether or not fast reaction time is due to practice or selection. Many physical education people believe learning and practicing skills improve reaction time. Is that why baseball players were the fastest in the tests? Or is it because they played baseball, and in so doing they learned and practiced movements similar to or identical with those used in measuring reaction time? Or are baseball players fastest because of selection since they would probably need to have fast reaction time to succeed in baseball?

In the numerous test and retest experiments done with motor activities and athletics, it is interesting to note that learning curves showing the practice effects from test to retest have not been published. Learning curves that deal with specified practice periods and represent some of the original learning of a specific act have appeared, but none are concerned with reminiscence, i.e., learning without practice.

According to the literature reviewed above, it would be expected that the movements involved in simple reaction-time responses would be unaffected by practicing typical physical education skills, since the simple finger movement involved in key pressing is not present in any of them to any important extent. Furthermore, this is a very simple type of movement and should not be greatly affected even by direct practice.

A standardized coordinated movement such as the peg-shifting employed by Miles (11) is much more complicated, and hence should be more affected by direct practice. Physical education activities, however, do not involve movements very similar to peg-shifting, so there should be no improvement due to transfer if only identical elements are transferred. If exercises of speed and skill have any general (rather than specific) effect, practice with such activities should transfer and speed up the peg-shifting.

By modifying the peg-shifting movement so that it involves considerable elements of horizontal and vertical movement of the arm, there is introduced a type of movement that is an element of some of the physical education activities, and in this case practicing the physical skills should transfer and speed up the movement to the extent that there is a common element in both.

The problem is to determine the extent to which practicing some physical skills, including a few of those commonly used in phys-

ical education curricula, affects the speed of certain simple and more complex standardized movements such as finger press and peg-shifting. Specifically, the skill activities of table tennis and quickening exercises involving fast horizontal and vertical arm movements will be tested for their possible transfer effect on reaction time and peg-shifting.

PROCEDURE

Forty-seven high school boys and girls, comprising four separate groups, were tested during the first three weeks of the school year. A period of approximately two months followed during which each group received a different type of physical activity. Each subject was then retested. The physical activities selected for practice between tests included the game of table tennis, special arm and quickening exercises, and a regular physical education class program.

Three tests, namely finger press, peg-shifting, and modified peg-shifting, were selected in order that it might be determined from what physical activities and to what degree transfer could occur. Each of the three tests is different in movement and they are graduated in terms of difficulty, in magnitude of movement, and in amount of time required to complete the act. Each is simple, relatively easy to do, requires little explanation, and is not physically or mentally fatiguing. All are simple to measure in time units.

Group A.—The control group consisted of a group of fourteen girls who did not participate in physical education activities because of physical disabilities. This group refrained from physical education participation for the duration of the experiment.

Group B.—This group consisted of eight boys who were active only in table tennis and had no other systematic physical education activity for the period of the experiment. This table tennis group did not participate in physical education activities on a normal basis because of physical disabilities. Each individual played table tennis at least three times weekly and took part in three-table tennis tournaments between tests.

Group C.—This was a regular physical education group of thirteen boys who took part in calisthenics, touch football, basketball, tumbling, and mass games.

Group D.—This group was a regular physical education group of twelve boys who had the same activities as Group C with the difference that three special arm exercises were substituted for the calisthenics. Two of the exercises, arm extension and the Randolph shuffle (to be explained later), were given at the beginning of each period. The third arm exercise, consisting of rapid coordinated movements, was added at the fifth week. The number of times each exercise was practiced increased progressively from twenty per period

at the beginning to forty per period at about the eighth week. The group did the exercises in unison, with each movement being robust and brisk. The boys were encouraged to make each movement as lively and forceful as possible. Following is a description of the exercises:

1. *Arm extension*:

   Starting position—hands to chest, palms down.
   First count—extend arms quickly and vigorously sideways.
   Second count—return to original position rapidly and forcibly.

2. *Arm coordination*:

   Starting position—attention.
   First count—arms forward, palms down.
   Second count—arms sideways, palms down.
   Third count—arms forward, palms down.
   Fourth count—arms upward, palms down.
   Fifth count—arms forward, palms down.
   Sixth count—arms sideways, palms down.
   Seventh count—arms forward, palms down.
   Eighth count—arms at side (attention).

3. *Randolph shuffle:*

   Starting position—attention (hop between each count).
   First count—arms forward, left foot forward.
   Second count—arms sideways, left foot sideways.
   Third count—arms forward, left foot forward.
   Fourth count—attention position.
   Fifth count—arms forward, right foot forward.
   Sixth count—arms sideways, right foot to right.
   Seventh count—arms forward, right foot forward.
   Eighth count—starting position.

The timer was a Klopsteg impulse counter which operated on 110 volts 60 cycles and measured time units of 1/120th of a second. The apparatus has been described by Miles (11). The experimenter's key was electrically controlled so that whenever it was pressed down (starting the chronoscope and the buzzer), it remained down until the subject broke the circuit by pressing down on the subject's key, thereby stopping the chronoscope and the buzzer. Following is a description of the tests:

1. *Simple Reaction Time.*—This involved reaction time to an auditory stimulus (a buzzer). The subject reacted to the auditory stimulus by pressing down a telegraph key with the forefinger of the favored hand. He was given a verbal ready signal and (after a few seconds) the stimulus. Having reacted once, the *preceding* stimulus served as the ready signal for the next reaction. Ten reactions formed one series which was followed by a brief rest. The period

between the ready signal and the stimulus varied irregularly by chance order between 1 and 3 seconds, this being near the optimum length (Breitweisser, 1; Woodrow, 20). Eleven series or 110 individual reactions per subject were given, followed by 110 reactions in peg-shifting and 110 reactions in modified peg-shifting as explained below. This completed the first test. After a period of about two months of interpolated exercises a retest using the same number of reactions was given.

2. *Peg-Shifting.*—The subject moved his right hand from the key, grasped a peg that stood upright in a hole four inches away, moved it to another hole six inches further and returned his hand to the key. This movement was repeated, shifting the peg from hole to hole and touching the key in between each shift of the peg.

3. *Modified Peg-Shifting.*—The subject removed his right hand from the key, placed it in a hole twenty-four inches to the right of the key and twelve inches higher and returned his hand to the key. This movement was repeated, shifting the peg from hole to hole and touching the key in between each shift of the peg. Otherwise, the instructions and procedure were the same as for peg-shifting.

4. *Reliability of Tests.*—Since the specific problem involves the comparison of group means, and is not a study of individual differences, the question of test reliability is unimportant. Nevertheless, some readers may be interested in knowing the effectiveness of the tests as measures of individual differences. The test-retest reliability for 47 high school subjects was r=.837 for simple reaction time, r=.871 for peg-shifting, and r=.827 for modified peg-shifting.

CONTROL OF EXPERIMENTAL CONDITIONS

It is essential that the test and retest conditions be identical and that no factor or factors enter in that would influence the results systematically. Listed below are the methods used to establish controlled conditions:

1. *Motivation.*—Motivation, insofar as possible, remained the same from test to retest. All subjects were informed that the purpose of the experiment was to measure the reaction time of different individuals. Upon retesting they were told more data were required. At no time was any subject compared with or in competition with another nor were they informed of their scores.

2. *Sensory or motor set.*—No instructions were given on this factor. The subject was advised to react as quickly as possible.

3. *Time of day.*—Elbel (4) in 1939, while using an auditory stimulus, discovered that on the average reaction times are fast in the morning and in the afternoon, while the slowest periods are in the early morning and around noon. Individual reaction times vary in a similar pattern throughout the day. Keeping these conclusions

in mind, each individual of the present experiment was retested within one half hour of the time of day at which the original test was taken.

4. *General well-being of the subject.*—The subject was questioned before each test as to how she or he was feeling that day. In all cases the reply gave no justification for eliminating any particular subject.

5. *Order of testing subjects.*—So that no testing order would be introduced that might influence the results in a systematic way, the members of the four groups were tested in a random order.

6. *Apparatus.*—The apparatus was not moved from test to retest so that noise, light, timing apparatus, and other conditions remained as constant as possible.

The chronoscope was calibrated by checking it from time to time with a reliable stop watch. This was accomplished by quickly pressing the stem of the watch against the experimenter's key, starting the watch and the chronoscope simultaneously. After approximately thirty seconds had elapsed on the stopwatch, the stem of the watch was quickly pressed against the telegraph key, stopping the watch and the chronoscope. Five calibrations were made and averaged at each of eight times during the experiment (Table I).

TABLE I

TIMER CALIBRATIONS

Time of calibrations	*First test*	*Retest*
Pre-test	plus 0.59%	minus 0.76%
First third	minus 0.04%	minus 0.53%
Second third	minus 0.97%	minus 0.29%
Post test	minus 0.96%	minus 0.75%

The results show that the chronoscope ran a little bit slower than the stopwatch except for the first calibration. The average difference between the stopwatch and the chronoscope was minus 0.34 percent in the first test and minus 0.58 percent in the retest. That is, the chronoscope tended to run minus 0.24 percent or about ¼ of 1 percent slower in the retest. This difference is within the range of error of the calibration method, and is too small to have had any appreciable effect on the experiment.

DISCUSSION OF DATA

Information was collected at the time of the retest in regard to the kind and amount of activities participated in over and above what was done as part of this experiment. This was done to discover any outside activity which could bias the retest. Only those activities were considered that were started and carried on during the time of the experiment. (Any activity carried on previously to the first test

would affect both test and the retest; whereas, an activity begun after the first test might possibly alter the results of the retest only.) No activities were found that could influence either the peg-shifting or modified peg-shifting tests. However, seven subjects commenced activities which could have influenced the simple reaction-time test. Six started beginning typing and one began clarinet lessons. Both of these require rapid fingering motions similar to the finger press movement. Tables II, III and IV give a summary of the results.

TABLE II

OUTSIDE ACTIVITIES OF THE CONTROL GROUP IN RELATION TO TEST SCORE CHANGES

Control Group: Mean difference for the group from test to retest: 0.021 seconds.

Subject	*Activity*	*Difference between test and retest*
No. 1	Clarinet	0.003 seconds
No. 10	Typing	0.019 seconds
No. 12	Typing	minus 0.006 seconds

No subject increased more than the average difference for the entire group. (The minus change means that this subject had a slower reaction in the retest.)

TABLE III

OUTSIDE ACTIVITIES OF THE SPECIAL EXERCISE GROUP IN RELATION TO TEST SCORE CHANGES

Special Exercise Group: Mean difference for the group from test to retest: 0.036 seconds.

Subject	*Activity*	*Difference between test and retest*
No. 2	Typing	0.030 seconds — an increase not larger than average difference for entire group.

TABLE IV

OUTSIDE ACTIVITIES OF THE TABLE TENNIS GROUP IN RELATION TO TEST SCORE CHANGES

Table Tennis Group: Mean difference for the group from test to retest: 0.016 seconds.

Subject	*Activity*	*Difference between test and retest*
No. 2	Typing	0.015 seconds
No. 3	Typing	0.028 seconds
No. 6	Typing	0.012 seconds

Subjects No. 2 and No. 6 of Table IV showed increases but not as large as the average difference for the entire group. Only one subject, No. 3, had an increase larger that the mean increase for his group; this increase of 75.0 percent was great enough to warrant concern, although it need not be necessarily considered a transfer effect. Of the eight subjects in his group, two others had increases over fifty percent although no activity was apparent from which

transfer could have occurred for them. Also, among the subjects who took the typing course, most of the individuals had increments that were either negative or so small that no transfer was indicated.

TABLE V

AVERAGE TIME PER TRIAL IN SECONDS FOR 110 REACTIONS PER PERSON IN TEST AND RETEST, AND STANDARD DEVIATIONS

Number in Group	14		12		13		8	
	M	σ	M	σ	M	σ	M	σ
Simple R.T.								
Test	.202	*.0273*	.194	*.0362*	.180	*.1215*	.170	*.0213*
Retest	.181	*.0221*	.158	*.0323*	.160	*.0312*	.154	*.0150*
Peg-Shift								
Test	1.010	*.0922*	.978	*.0904*	.963	*.0609*	1.000	*.1069*
Retest	.938	*.1035*	.907	*.0865*	.896	*.0678*	.898	*.1015*
Modified Peg-Shift								
Test	1.510	*.1237*	1.428	*.1477*	1.370	*.0988*	1.444	*.1443*
Retest	1.382	*.1517*	1.325	*.1355*	1.321	*.0808*	1.333	*.1366*

The average response times are shown in Table V. These high school students tended to react somewhat faster than the subjects in Miles' experiment (11) perhaps because they were younger. His average time for the finger press was .23 seconds and for peg-shifting, 1.10 seconds (he did not study the modified peg-shifting movements).

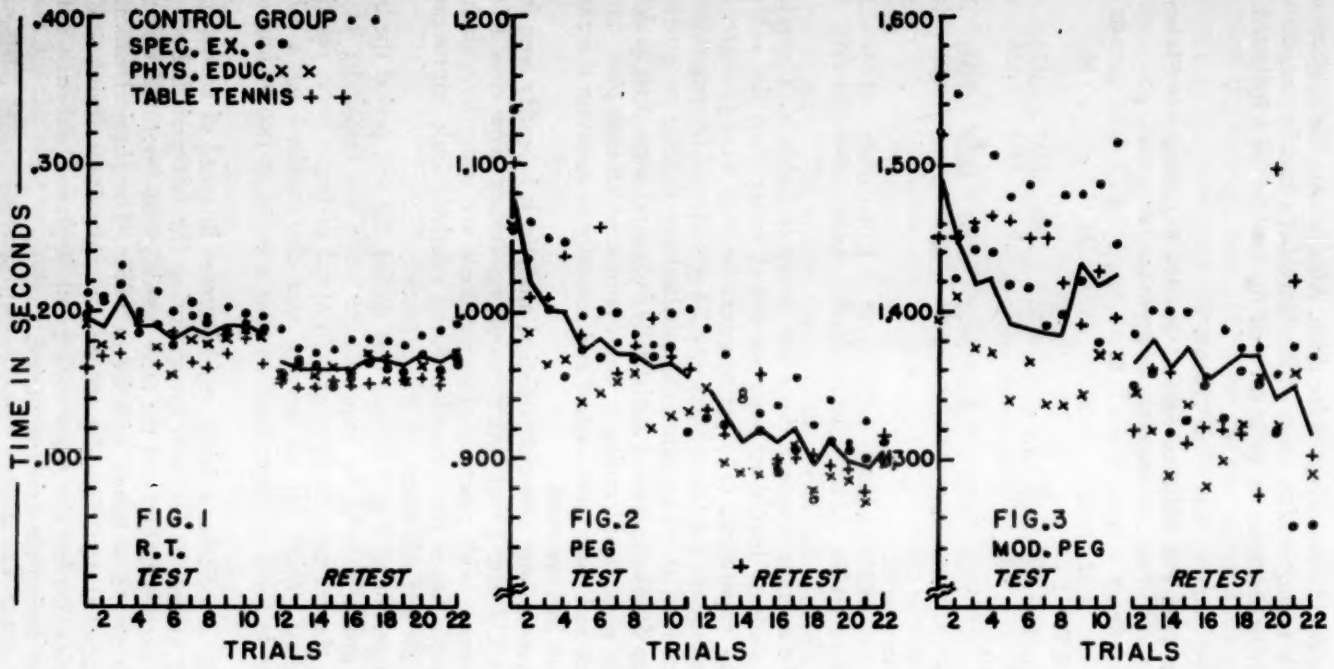
The data were treated statistically in several ways, first to determine the amount of learning or improvement which took place during each test and from test to retest and secondly to ascertain if a transfer effect had occurred.

Even without a formal statistical analysis, it is readily seen from Figures 1, 2, and 3 that both types of peg-shifting show considerable improvement with practice, although there are many irregularities. The simple finger press reaction shows relatively little improvement *during* the test and retest, as was expected.

Inspection of Fig. 1 reveals that during the test period the table tennis group showed no improvement while the remainder of the groups showed only a slight gain in speed of finger press reaction. The retest period for all groups was characterized by a slight decrease in speed of finger reaction after a series or two of improvement.

Fig. 2 indicates a fairly rapid increase in speed of normal peg-shifting movement for each group during the test period. Both the special exercise group and the table tennis group improved throughout this period, although with irregularities. The physical education and control groups showed a tendency to slow down during the last two series. During the retest each group improved, although not as much as during the first test period.

Modified peg-shifting improvement is considerable during the



Figs. 1, 2, 3 (left to right). Learning due to practice of reaction time and peg-shift during the course of the brief testing periods. One trial consists of ten individual reactions per subject. The curves show the average of the entire group of 47 high school students.

test period (Fig. 3). Each group improved in speed of movement, but there was a general tendency for the improvement to decrease during the last few series. The retest period shows that the improvement in speed of modified peg-shifting continued, but not as much as during the first test period. Each group shows improvement, especially during the last few series.

The data (Figs. 1, 2 and 3) show greatest improvement in the

TABLE VI

COMPARISON BETWEEN THE VARIOUS GROUPS IN TERMS OF THE CRITICAL RATIO "t," USING SMALL SAMPLE STATISTICS (5)

	Control	*Special Exercise*	*Normal P.E.*	*Table Tennis*
Reaction Time				
Control		0.60	2.25*	2.90**
Spec. Ex.	*2.08**		1.12	1.77
Normal P.E.	*1.93*	*0.15*		0.98
Table Tennis	*3.23***	*0.36*	*0.57*	
Peg-Shift				
Control		0.86	1.51	0.21
Spec. Ex.	*1.65*		0.46	0.45
Normal P.E.	*1.24*	*0.35*		0.84
Table Tennis	*0.84*	*0.19*	*0.05*	
Modified Peg-Shift				
Control		1.46	3.14**	1.02
Special Ex.	*0.97*		1.10	0.23
Normal P.E.	*1.27*	*0.09*		1.20
Table Tennis	*0.74*	*0.12*	*0.21*	

* Significant at the 5% level.

** Significant at the 1% level.

Figures in italics are from the retest; the others are from the first test.

most complicated coordinations, as was anticipated. Quite unforeseen was the large improvement without practice (technically termed *reminiscence* by psychologists, 22, p. 68), that took place during the two months' interval between test and retest.

A possible explanation is as follows. The subjects took the tests in the following order: coordination No. 1, simple reaction time; coordination No. 2, normal peg-shifting; coordination No. 3, modified peg-shifting. The improvement is not reminiscence, but rather due to the practice on normal peg-shifting and modified peg-shifting *after* simple reaction time (coordination No. 1), but before retest on simple reaction time. This would be transfer of training. But then about the same or maybe more improvement would be expected on coordination No. 2 retest and coordination No. 3 retest, since the *identical elements available for transfer* would be the same as in the case of simple reaction time, as shown by the schema in Table VII.

So in reality there would be the same practice in the other two coordinations for Nos. 1, 2 and 3, but the test-retest interval would come in a different place. Actually there is no test-retest improve-

TABLE VII

SCHEMA OF PRACTICE ON THE OTHER TESTS DURING THE TEST-RETEST INTERVAL

For No. 1:	*For No. 2:*	*For No. 3:*
No. 1 test	No. 2 test	No. 3 test
No. 2 practice	No. 3 test	Interval
No. 3 practice	Interval	No. 1 practice
Interval	No. 1 practice	No. 2 practice
No. 1 retest	No. 2 retest	No. 3 retest

ment for No. 2, but there seems to be some effect on No. 3 (modified peg-shifting) to the extent of about 25-35 ms and about the same in No. 1 (simple reaction time) when the comparison is between adjacent parts of the learning curve, i.e., series 7-11 at the end of the test and series 1-5 at the beginning of the retest. Considering the special exercise group alone, the results are the same; no obvious change in the curve between test and retest on No. 2 (normal peg-shifting), but a definite improvement, 100 ms in coordination No. 1 and 30 ms in coordination No. 3.

Therefore, as the improvement between No. 2 and No. 3 was not the same—in fact almost opposite—there is no evidence of transfer from one test skill to the other (e.g., from finger press to peg-shifting).

Reminiscence, or learning without practice, is explained by Woodworth (22) as the reviewing which sometimes takes place by the varying chances of recall and conditions of recall, and by the improvement of readiness for recall of previously learned material. Each of these factors could account for portions of the improvement between test and retest. Probably the most important factor in this learning process is the reviewing which could have taken place after each subject had orginally been tested. This is perserveration and according to Woodworth (22) amounts to an involuntary review of the act just completed. Although not conscious that a retest would be made, it is possible that each subject thought about the test after its completion. This process would vary from individual to individual depending on the amount reviewed. Mental practice can cause improvement in motor skills (19).

To discover if transfer of the physical education skills has occurred, it is necessary to compare the control group with the other groups. If the amount of improvement in any of the three groups is greater than the improvement of the control group, and this difference is statistically significant, we can say that transfer has taken place.[1]

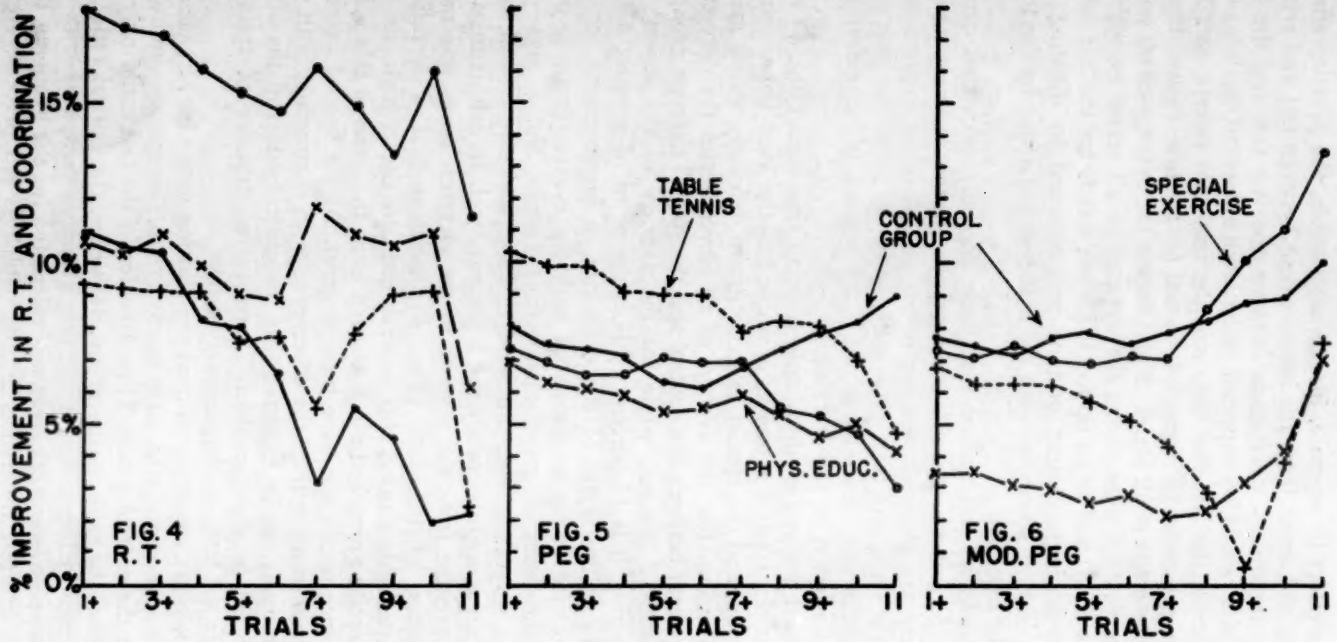
[1] According to Guilford (5) a "very significant" difference is one that occurs by chance less than one in one hundred times. This requires a "t" ratio or critical ratio (i.e., ratio of the difference to its standard error) of approximately 2.8 depending upon the exact number of individuals involved. A critical ratio of about 2.0 is significant at the 5 percent level.

In an effort to separate, insofar as possible, the practice effects within test and retest from the improvement between test and retest, a set of comparisons were made between the last test and the last retest (which would be expected to be least influenced by intra-test improvement), the last two tests and the final two retests, etc. The results are presented in Figures 4, 5, and 6. In these figures 1 plus means the average of all series; 2 plus means the average of all series except the first; 3 plus means the average of all series except the first and second; and so on up to 11. Eleven stands for the last series only. Percent improvement in time was obtained by dividing the difference in time scores between the first test and retest by the total time on the first test.

It should be emphasized that these specially calculated curves (Figs. 4, 5, and 6) are not truly graphs in the ordinary sense; rather, they are pictorial representations of test-retest improvement using all the data, and then eliminating series by series the first part of the "within test" learning to see if the amount of test-retest differences is affected by this learning.

A visual analysis of the simple reaction time data (Fig. 4) discloses that the control group as a whole has the least improvement of any group, and the special exercise group definitely shows greatest improvement. For the average of all eleven series the difference in improvement between the control and the special exercise group is approximately 7 percent, while for the average of the seventh to eleventh series, it is 13 percent (this is the point of greatest difference). The critical ratio of the difference in improvement for the special exercise group as compared with the control group is only 1.94 for the point of greatest difference (series No. 7 plus—the average of seventh to eleventh series). This particular critical ratio is significant at approximately the 5 percent level. In calculating this ratio the average from the seventh to the eleventh series was used. An inspection of the data (Fig. 4) indicates that a fortuitous response probably caused this critical ratio to be so high. If the special exercise group had not fluctuated from the trend at this point, the difference would not have been as great. As the special exercise group increased more than the other groups in comparison with the control group, it can be expected that the critical ratios of the other groups would be even smaller. Therefore, no transfer of training occurred in the tests of simple reaction time.

An examination of the normal peg-shifting data (Fig. 5) clearly shows only one group, the table tennis group, has greater improvement than the control group. Thus, transfer in the test could only be possible from the table tennis group. However, the critical ratio for the difference in improvement for this group as compared with the control group is only 0.66. This was calculated for the grouping that shows the greatest difference, 5 plus, which is 2.6 percent. Again



Figs. 4, 5, 6 (left to right). Transfer effect from two months of the quickening exercises (special arm exercises, physical education classes, and table tennis), calculated as percent improvement in reaction time or peg-shift coordination when retest scores are compared with the first test. In these figures, 1 plus represents the average of all trials; 2 plus, trials 2 through 11; 3 plus, trials 3 through 11; 10 plus represents the last 2 trials, and 11 is the last trial only.

no transfer is proved as this figure is not significant statistically. Therefore, it can be said that no transfer of training occurred from any of the exercise movements to normal peg-shifting.

Inspection of the modified peg-shifting data (Fig. 6) discloses that only one group exceeded the control group in percent of improvement, the special exercise group. A critical ratio of 0.28 was obtained by comparing the difference in improvement for the special exercise group with the control group for series 11. Except for series 8, 9, 10, and 11 with the special exercise, improvement is greatest in the *control* group. Modified peg-shifting is the test in which greatest transfer was anticipated. Hence, no transfer of training occurred to the modified peg-shifting test from the special arm exercises, playing table tennis, or participation in the regular physical education activities.

On the whole, it may be concluded that there was no transfer of training from any of the practiced movements (special arm exercises, playing table tennis, or participation in the regular physical education activities) to any of the tested movements (simple finger press, normal peg-shifting, and modified peg-shifting). It was necessary to limit the exercise period to two months because of practical considerations. Possibly there would have been some transfers if the exercises had been continued for a very long period of time, although it seems unlikely because even five minutes of exercises a day for two months is an extremely large amount of practice compared with the five minutes' experience the subjects had with the peg-shifting test. Yet this small amount was enough to produce a definite improvement in the peg-shifting skill (Figs. 1, 2, 3).

SUMMARY AND CONCLUSIONS

In order to find out if quickening exercises could be expected to improve speed in other muscular activities, forty-seven high school boys and girls were tested in three different coordinated muscular movements: simple finger press, normal peg-shifting, and peg-shifting modified to include considerable lateral and vertical arm movement. A period of approximately two months followed in which the students were divided into four groups, depending on the activity:

1. No physical activities.
2. Regular physical education program.
3. Regular physical education program plus special arm exercises.
4. Table tennis only.

The four groups were then retested to investigate (a) the amount of learning during the test and during the retest, (b) how much improvement occurred between test and retest, and (c)

whether practicing the listed physical activities transferred to improve coordination efficiency in the test performances.

1. There is no transfer of training from the activities of table-tennis, regular physical education, or special arm exercises to coordination efficiency in the finger press, normal peg-shifting, or modified peg-shifting as measured by speed of movement. Evidently, a significant transfer of training does not occur when some of the movements are similar as is the case in the special arm exercises and modified peg-shifting. Instead the results agree with the theory that transfer is highly specific and occurs only when the practiced movements are identical.

2. Definitely disproved is the theory that "quickening exercises" or sports activities (such as table tennis) that involve many rapid skillful movements improve the individual's general coordination.

3. Learning definitely does take place during the performances of the test activities and also to some extent during the elapsed time between the taking of the test of coordination efficiency and the retest with no practice during that interval. This learning is probably of two kinds: (a) the immediate practice effect of performing the movements of the original test and (b) reminiscence (i.e., improvement without practice).

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Influence of Athletic Success and Failure on the Level of Aspiration

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INTRODUCTION

IN recent years psychologists have made considerable use of the term "level of aspiration" which is the goal that a person announces he intends to achieve in some future performance. The concept, according to Gardner (5), was first suggested by Hoppe (10) as a technique for studying the psychological factors which operate in producing feelings of success and failure. Success and failure in an activity depend upon the subject attaining an intermediate goal which he himself has set, success and failure being defined in terms of their relation to the level of aspiration. Success is performance above this level, and failure is performance below it.

That marked individual differences appear in aspiration-level studies has been shown in some of the earliest findings (6). Some individuals exhibit levels of aspiration which they do not think they will attain and when there could be no possible reason for such high expectations on the basis of past performance. Gould (7) contends that such high levels of aspiration are exhibited by subjects because they wish to appear ambitious. It is possible that such individuals have more ambition, or daring, and may keep their aspiration level high as an incentive to do better than ordinarily would be the case. Other individuals, to be provided with a satisfying or successful experience, may keep their aspiration-level so low that they are practically certain to reach or extend beyond it. A more realistic attitude is exhibited by subjects who maintain their level of aspiration near the level of past performance (6).

It can be seen that the level of aspiration may serve as a threat to the subject's evaluation of himself. The subject must commit himself as to his expected performance and then exhibit his ability before someone else. If he fails in that performance, clinically observable tension and frustration may result, and to prevent a possible recurrence, he may lower his level of aspiration for the following performance so that frustration is either greatly reduced or elimin-

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ated entirely. The subject's manipulating of the level of aspiration in this manner makes it possible for him to adjust his next level of aspiration to the past performance. Attempts to eliminate frustration and tension by making the level of aspiration coincide with the level of past performance have been shown in many studies (1, 3, 4, 6, 7, 12, 14). Some subjects avoid responsibility and frustration by setting their aspiration-level unattainably high (6).

Failure (i.e., defeat or frustration) produced by falsely reporting low performance scores to young men so that there would be a discrepancy between performance and level of aspiration, is accompanied by overt symptoms of conflict that disappear when no aspiration-levels are required (13). Thus, the discrepancy between performance and aspiration-level may be taken as a technical measure of failure or frustration, although it is not to be interpreted as a measure of the psychological result of this failure or frustration.

The problem attacked in the present study concerns the effects of success and failure on the level of aspiration in a real-life situation. The subjects were the members of the 1947 freshman football squad of the University of California. Objectively, these boys differed in the degree of success and failure they experienced in that some boys played quite regularly in all scheduled games, whereas others were given the opportunity to play but seldom and for only short periods of time. The exact amount of time played was determined by the decision of the head football coach and his assistants in accordance with their estimate of an individual's ability and growth in ability.

The specific questions to be investigated are: how much frustration or failure (technically defined) occurs among the members of a typical football squad, and to what extent does this depend upon such factors as a player's ability and the degree of objective success experienced from game to game.

PROCEDURE AND DEFINITIONS

Discussion of the procedure requires specific definitions of the terms "level of aspiration," "success," "failure," and discrepancy score.

The use of the term "level of aspiration" by recent investigators has followed the behavioral definition by Frank:

> (The term) level of aspiration . . . is . . . the level of a future performance in a familiar task which an individual, knowing his level of past performance in that task, explicitly undertakes to reach (2, p. 119).

For the purposes of the present study, level of aspiration is interpreted much as Frank has stated it with the exception that the subject is not explicitly informed of his level of past performance.

Success and failure (again following Frank) have been defined

in terms of their relation to the level of aspiration: success is a performance above it, and failure a performance below it. The discrepancy score is defined as the difference between the performance and the next expressed level of aspiration (2, 6, 8, 9). If the level of aspiration is greater than the past performance the discrepancy score is "negative," and if it is less, it is "positive." This amounts to reversing the sign as used by Frank. Thus, success and failure are concerned with the extent to which a person reaches a previously announced goal, whereas discrepancy is concerned with the effect of performance on a subsequently announced goal.

The means most commonly employed to ascertain an individual's level of aspiration has been to ask S (the subject)[2] to make some sort of statement concerning a future performance. The difference in the experimental procedure has been in the type of statement S is asked to make. Frank (2) asked the subject, "how well do you intend to do on the next repetition?" Sears (16), after informing S how he had done on one trial, asked: "what are you going to try to do this in?" Gardner (6), using a percentile scoreboard, employed the method of having S set an *ultimate* level of aspiration by asking him "to indicate the percent of the group which you expect to surpass when you have had twenty trials of practice. In other words, I want to know before you start how good you expect to be when you are at your best." Gardner (6) also asked S to set an *immediate* level of aspiration referring to the immediately succeeding performance.

That the type of question put to the subject may have some effect on the response was shown by Irwin and Mintzer (11). In a dart-throwing experiment, variations in the instructions given as to the kind of aspiration statement required showed large and significant differences in discrepancy scores. "Hoped for" scores exceeded performance scores to a greater extent than "expected" scores.

Rotter (15) found that subjects interpreted instructions differently and showed variations in the way they interpreted the same instructions.

It would appear that the selection of instructions is of some importance in a study of the level of aspiration. In a competitive sport, where the subject is highly motivated, considerable differences may be evidenced in answers given to "hoped for" and "expected" questions.

In the present study a simple chart was selected upon which S was asked to designate his level of aspiration. It was made of white cardboard, thirty inches by six inches, and divided into equal

[2] Following the usual abbreviations of psychological literature, S and Ss are singular and plural symbols for the subjects; E denotes experimenter.

segments from zero to sixty, representing the sixty minutes of time available in a football game.

Subjects were interviewed privately on Wednesday, Thursday, and Friday afternoons preceding the scheduled intercollegiate games which were played on Saturday.[3] On the first two interviews a prepared statement was read to S, and without speaking he used a wooden pointer to designate his level of aspiration, (that is, the number of minutes he thought he would play in the game that week). This score was then recorded as his immediate level of aspiration (I. L.). S was then asked to indicate in the same manner the maximum number of minutes he thought he would play in some game before the season ended. This was recorded as his ultimate level of aspiration (U. L.).

The number of minutes played in each game was recorded the following week, preceding the interviews, but S was never informed of the number of minutes he had played. When S requested time played, E informed him that tabulating sheets were not at hand and that final tabulations would not be made until the season ended. This was thought to be an advantage, for E at no time discussed with any S the length of time played in any game, although it was obvious that some Ss had played more than others.

DATA AND DISCUSSION

It is interesting to compare the average level of aspiration for game 1 between Ss who finished the football season with the squad and those who dropped out before the end of the season for one reason or another (the coaches did not "cut" boys from the squad). The average level of aspiration preceding game 1 for eight Ss who quit was 3.4 minutes as compared to 16 minutes for 44 who did not quit. This would seem to indicate a lack of self-confidence on the part of these subjects (insofar as their prospects of playing were concerned). If these averages may be taken as an indication of Ss who are likely to quit, it is possible that a word of personal encouragement from members of the coaching staff might dissuade these subjects from dropping out. However, this might be undesirable since these Ss may not be good enough to play very much anyway.

The boys who quit before the end of the season can be predicted quite well on the basis of their immediate aspiration-level. The correlation coefficient (estimated from phi) is .56, and chi-square is 10.6, which is highly significant. In contrast the *ultimate* level of aspiration fails completely to predict whether or not a player will quit before the end of the season, or if he would be chosen to play in the final game.

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[3] The writer, who was backfield coach of the football team used in the experiment, made the interviews personally. Rapport was excellent.

During the course of the playing season there is a lowering of the average level of aspiration (Table I) except that the third game, which was won, was followed by a rise in the level.

TABLE I

IMMEDIATE LEVEL OF ASPIRATION FOR EACH GAME IN MINUTES

	M.	S.D.
Game 1	15.24	8.67
Game 2	15.	10.6
Game 3	14.25	10.9
Game 4	17.4	9.8
Game 5	14.2	10.8

The explanation of the rise in game 4 is that this game was played in Los Angeles and because the poorer players were excluded from the trip, their levels of aspiration were not obtained. The actual change in immediate level of aspiration of those who made the trip was downward (averaging 0.6 minutes).

TABLE II

INTERCORRELATIONS BETWEEN TIME PLAYED EACH GAME AND LEVEL OF ASPIRATION NEXT GAME

	r
1. Time game 1 with I. L. game 2	.80
2. Time game 2 with I. L. game 3	.73
3. Time game 3 with I. L. game 4	.81
4. Time game 4 with I. L. game 5	.70
5. U. L. game 1 with most time played in any game	.155

The coefficients of correlation between time played in each game and the level of aspiration for the following game are shown in Table II. The bottom line in this table is the coefficient of correlation between the ultimate level of aspiration taken prior to game 1 and the maximum time played in any game; it is not statistically significant. Neither is there any statistically significant relationship between ultimate level for game 1 and the time played in game 5. However, the coefficient of correlation is .31 between immediate level for game 1 and time played in game 5. This is near significance. All other coefficients are statistically significant at the one percent level, and indicate a realistic attitude because the individuals who played the most are the ones who have the higher aspirations. The ultimate level or "hoped for" scores are probably less related to "reality" and more related to personality differences of an obscure sort than the immediate level or "expected" scores. Immediate aspiration-level had predictive significance, but the ultimate level did not.

The ultimate level of aspiration (Table III) shows a downward trend during the playing season very similar to that found for the immediate level, although the times estimated are nearly twice as high. Even though there are substantial correlations between the aspiration levels for the different games, aspiration is not a fixed unchanging characteristic of the individual.

TABLE III

SHOWING CHANGES IN ULTIMATE GOALS

	M.	S.D.
Ultimate goal, game 1	31.9	12.
Ultimate goal, game 2	26.7	12.6
Ultimate goal, game 3	23.7	14.3
Ultimate goal, game 4	22.1	13.

TABLE IV

CHANGES IN IMMEDIATE ASPIRATION-LEVELS

	Raise		*Lower*		*Unchanged*	
Comparison	*No.*	*%*	*No.*	*%*	*No.*	*%*
Game 2 with game 1	16	36	22	50	6	13
Game 3 with game 2	12	25	22	47	13	27
Game 4 with game 3	18	44	14	34	27	22
Game 5 with game 4	13	34	13	34	12	32

Looking at Table IV, it can be seen that the number of Ss who lowered their aspiration-level after game 1 (which was lost) represents 50 percent of the squad. For the next game, about the same proportion lower their level, but fewer raise their aspiration-level. Two consecutive losses at this time may be a probable explanation for this reaction. The third line of Table IV, which represents data taken after game 3 (which was won) shows 44 percent raising their aspiration-level, the greatest number at any time in the series. The last line indicates that losing game 4 again has an immediate effect as the percentage of those who raise their level of aspiration is ten percent lower than for the previous game.

The freshmen football players may be divided objectively into four teams, assigning the players to A, B, C, or D category on the basis of total time played during the season. Each of these teams has a normal complement of players at each position, except for team D which was minus one guard because there were but seven guards available on the squad. The A team agrees very closely with the head coach's first team picked by him to play in the last and most important game of the season. Ten out of the eleven boys who played most in the last game are on the synthetic A team. The eleventh member was high on the B team. Only one of the members of the D team was used by the coach in the last game.

The coach's judgment conditioned his choice as to who was the most successful, and least successful, from his original total

freshman squad; this was the major factor in determining who played in this last and most important game.

The number of individuals who experienced success (i.e., played the number of minutes they aspired to play) and the number who technically experienced failure (i.e., who failed to play the aspired number of minutes) varies greatly from team to team. The percentage of failures throughout the season is shown in Table V. The average failures for all teams in all games is 49.7 percent.

TABLE V

PERCENT OF INDIVIDUALS EXPERIENCING TECHNICAL FAILURE*

Game	*Team A*	*Team B*	*Team C*	*Team D*
# 1	56	64	67	89
# 2	36	40	50	78
# 3	36	20	50	70
# 4	18	60	55	50
# 5	9	45	56	67
Average	30.2	46.2	55.1	73.2

* Boys who played less than their aspiration-level.

Team A is characterized by fewer failures in the first game and a continual decrease of failures throughout the season. Team D presents just the opposite picture: failures are very high even for the first game and do not decrease a great deal. In game 4 the failures are fictitiously low because members not on the travelling squad were not included in the calculations. Only the four best players on this squad went on the trip.

The discrepancy scores, which represent the difference between amount of time played in a game and the next following announced level of aspiration, give a somewhat similar picture (Table VI). Negative discrepancies correspond somewhat to failure; these are the boys who aspired in excess of their game experience. They *hoped* to succeed. The differences are much less striking than for failure scores.

TABLE VI

PERCENT OF INDIVIDUAL NEGATIVE DISCREPANCIES BY TEAMS FOR SEASON

	Team A	*Team B*	*Team C*	*Team D*	*Team Av.*
2	56	73	63	75	67
3	45	45	33	56	45
4	27	30	64	80	46
5	36	40	44	60	43
Av.	40.5	47.5	51.4	66.7	50.

Team C shows the lowest percentage of negative discrepancy scores for game 3. Eight members of this team were named as starters for the next game early in the week, before interviews. This is a possible explanation for the lower percentage of negative scores for team C for this game.

In order to interpret the average levels of aspiration of the four teams it is necessary to have in mind the average number of minutes of play for each team in each game. It is interesting that for team A the average time goes up game by game as the season progresses. Teams B and C show little change during the course of the season except that team C had noticeably less play in the last game. Team D played very little at any time. Even in the first game the teams are clearly differentiated as to average time played, and the difference increases during the course of the football season. The average times are shown in Table VII.

TABLE VII

AVERAGE TIME IN MINUTES PLAYED PER GAME

Game	*Team A*	*Team B*	*Team C*	*Team D*
1	22.6	15.6	11.0	3.0
2	26.9	22.1	11.1	3.4
3	30.0	21.7	9.2	1.6
4	33.2	17.9	11.3	5.6
5	37.8	14.2	6.7	1.7
Mean	30.	18.3	8.86	3.06

The immediate level of aspiration goes up game by game for team A (Table VIII) but it does not go up as much as time played. For this reason the amount of success becomes larger and larger throughout the season for this team (Table IX). Teams B and C show much less change in aspiration-level although there is a tendency for both teams to decrease aspiration-level during the season (particularly team C). On the average both of these teams show failure rather than success as in team A. Team D starts out with a considerably lower level of aspiration than any of the other teams and the level drops more during the season than for any other team. The D team on the average is about as unsuccessful, technically speaking, as the A team is successful (Table IX). The D team experienced failure in all games—less so, perhaps, in game 4 because only four players were considered. The others, while failures, were not invited to make the trip and could not be scored.

TABLE VIII

AVERAGE IMMEDIATE LEVEL OF ASPIRATION IN MINUTES

Game	*Team A*	*Team B*	*Team C*	*Team D*
1	24.0	20.1	15.2	10.0
2	24.0	19.5	11.8	8.1
3	26.6	20.1	9.8	5.2
4	25.6	20.0	11.5	5.7
5	27.1	17.2	10.0	4.7
Mean	25.5	19.4	11.66	6.74

TABLE IX

AVERAGE SUCCESS AND FAILURE SCORES

Game	*Team A*	*Team B*	*Team C*	*Team D*
1	—1.4*	—4.5	—4.2	—7.0
2	+2.9**	+2.2	—0.7	—4.7
3	+3.4	+1.6	—0.6	—3.6
4	+7.6	—2.1	—0.2	—0.1
5	+6.7	—3.0	—3.3	—3.0
Mean	+3.84	—1.16	—1.8	—3.68

Average success and discrepancy scores are not exactly the same as the difference between average time played and average aspiration-level because some players were injured.

* Minus scores indicate failures.

** Plus scores indicate successes.

TABLE X

AVERAGE DISCREPANCY SCORES*

Game	*Team A*	*Team B*	*Team C*	*Team D*
1-2	—2.3	—3.9	—0.1	—5.1
2-3	+0.3	+0.9	+1.4	—2.0
3-4	+4.4	+1.7	—2.6	—2.0
4-5	+6.1	+1.0	+0.8	—2.3
Mean	+2.12	—0.08	—0.13	—2.85

* Aspiration for next game subtracted from time played in previous game.

The discrepancy scores (Table X) show that all teams were hopeful following the first game; they aspired to play more in the second game than they had actually played in the first. This is particularly noticeable in team D. Team A becomes realistic and conservative after the first game and ends the season with a decidedly positive discrepancy score. The changing level of aspiration has not kept pace with the coach's increasing use of these players in the games. In contrast, team D, while dropping its level of aspiration after the first game (and first disappointment), never catches up with reality—the discrepancy scores of the members remain at minus 2 for the rest of the season.

The ultimate levels of aspiration are shown in Table XI. Team

TABLE XI

AVERAGE ULTIMATE LEVEL OF ASPIRATION IN MINUTES

Game	*Team A*	*Team B*	*Team C*	*Team D*
1	35.1	35.8	27.4	30.6
2	34.9	29.4	22.8	24.2
3	34.8	30.7	20.0	14.2
4	33.8	27.8	17.3	10.2
5	27.1	17.2	10.0	4.7
Mean	33.14	22.2	19.5	16.8

TABLE XII

AVERAGE ULTIMATE LEVEL SUCCESS AND FAILURE SCORES*

Game	*Team A*	*Team B*	*Team C*	*Team D*
1	—13.2	—20.2	—26.4	—27.6
2	— 8.0	— 7.8	—11.7	—20.8
3	— 4.8	— 9.0	—11.3	—12.6
4	— 0.6	— 9.9	— 5.2	— 4.6
5	+ 6.7	— 3.0	— 3.3	— 3.0
Mean	— 3.98	— 9.98	—11.6	—13.7

* Time played minus ultimate level.

TABLE XIII

AVERAGE ULTIMATE LEVEL DISCREPANCY SCORES

Game	*Team A*	*Team B*	*Team C*	*Team D*
1	—13.4	—13.8	—11.0	—20.3
2	— 7.9	—11.4	— 7.8	—12.1
3	— 3.8	— 6.1	— 8.3	— 7.5
4	+ 6.1	+ 1.0	+ 0.8	— 2.3
Mean	— 4.8	— 7.6	— 6.6	—10.5

A did not change its ultimate level appreciably during the course of the season, excepting perhaps for game 5, where the ultimate level necessarily became the immediate level. Team B started with just as high an ultimate level as team A but lowered the ultimate goal as the season progressed. Team C dropped in aspiration, game by game. It started with a 27-minute aspiration, went down to 17 minutes at game 4, and ended the season at a 10-minute level. Team D started with a higher ultimate level than team C, and dropped to a third of its initial size when it reached game 4; by the end of the season it was down to a sixth of its initial size.

"Ultimate" success, defined negatively as failure to play enough in a particular game to reach the ultimate goal set before that game (Table XII), gives some interesting results. All teams show failure when it is defined in this particular way. In game 1, failure is least for team A and most for team D. This is equally true for all games. Team A experiences success in the last game, but no other team reaches its ultimate goal. Discrepancy scores based on ultimate level of aspiration show much the same relation as the success and failure scores (Table XIII).

On the whole, the psychological picture is one of uncertainty at the first game. However, most of the boys who eventually turn up in the D team experience failure in the first game. As the season goes on, members of the D team do lower their aspiration-level and become more realistic, but not sufficiently so to avoid failure. A very different picture is presented by the better players. While over half

of them experience failure in the first game, this is only a temporary state of affairs as failure among them is quite uncommon.

The unsuccessful players are frustrated insofar as their announced objectives are concerned. This "frustration" may not be—probably is not—of great clinical significance, but psychologically it is undesirable and "bad" to the extent that it probably creates tension and develops a constant pressure that the Ss cannot alleviate. When 50 percent of these four teams, as shown by the averages, technically experience "frustration," it carries broad implications of a practical nature for physical education and athletics.

Some colleges have seen the need for a "varsity" and a "rambler" squad, the latter usually comprised of eligible candidates who lack the experience and ability of the former. The "rambler" team plays an entire schedule of its own and members may move up to the "varsity" as the season progresses. It is possible that the introduction of a similar practice for the freshman team would lessen the possibility of tension or "frustration" if the two-team schedule were employed. It would, at least, give more boys an opportunity for participation than the present one-team schedule.

In the field of physical education these findings may be of considerable value to the teacher who is primarily interested in what can be done for the student.

SUMMARY AND CONCLUSIONS

The fifty-nine members of the university freshman football squad were interviewed prior to each game during the season and requested to indicate quantitatively their "immediate levels of aspiration" (i.e., the number of minutes they thought they would play in that game) and their "ultimate aspiration" (i.e., the number of minutes they thought they would play in some game before the season ended).

The boys were formed into four "synthetic" teams, choosing players having the most playing time in their position for the A team and players with the least time for the D team. There were also intermediate B and C teams.

The average playing time of the A team increased from 23 minutes for the first game to 38 minutes for the last game of the five-game schedule. The average immediate level of aspiration went up from 23 minutes to 27 minutes during the course of the season. Thus, the aspired-to amount of time was played, on the average, in the first game. By the end of the season the aspired time for a particular game was greatly exceeded by the actual time played. The difference amounted to 25 percent.

The D squad, in contrast, averaged 3 minutes of play in the

first game, which was 70 percent below the aspired ten minutes. In the last game, the time played was 64 percent below the immediate level of aspiration of 5 minutes. This squad experienced a high degree of failure throughout the season. Even though their hopes were slight, they were not realized.

Thirteen of the boys were not good enough to play in scheduled games at any time. Seven of these boys quit the squad; their immediate level of aspiration averaged only 3.4 minutes for the first game and none aspired to more than ten minutes of play. Thus, the highest aspiration of this group was less than the average aspiration of all other players—16 minutes for the first game. One other player quit the squad. His aspiration level was also low, 8 minutes.

Fairly high correlation coefficients were found between immediate levels of aspiration and amounts of time played. For example, time played in game 1 correlated .80 with the immediate level of aspiration in game 2. However, the ultimate level of aspiration was found to be unrelated to objective behavior. It correlated only .16 with ultimate accomplishment, and failed to pick out the players who quit the squad.

It seems reasonably safe to conclude on the basis of the evidence presented, that in the real-life situation presented by the freshman football squad:

1. There is a tendency for successful individuals (those who get to play the most) to raise their level of aspiration, and for failures (those who get to play the least) to lower their level of aspiration.

2. Individuals who have extremely low levels of aspiration, after having experienced failure objectively, tend to escape by overt action which removes them from the failure-producing situation.

3. Individuals with somewhat higher levels of aspiration maintain some hopes of success and repeatedly experience failure.

4. Individuals with the highest levels of aspiration tend to repeatedly exceed their aspiration-level and experience success, even though this success has caused them to raise their aspiration-level.

5. The ultimate level of aspiration is uncorrelated with ultimate accomplishment.

6. The immediate level of aspiration is definitely correlated with immediate accomplishment and related to toleration of, or escape from, the failure-producing situation.

7. These facts suggest that in real-life athletic situations such as those occuring in the case of the freshman football squad, a considerable number of the players are forced to experience failure repeatedly and consistently.

A considerable part of this frustrating experience could be avoided by the addition of a second-grade competitive team playing a separate schedule. To the physical educator the implications are clear: competitive team play should be on a broad basis and should give adequate consideration to graded competition.

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The Basic Walking Load Involved in Attending the University as Measured By a Pedometer:

I. The Walking Load of College Women

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(Submitted for publication, June, 1948)

THE ability to walk has become almost a prerequisite to securing a college education. The expansion in the building program of colleges and universities has necessitated greater and greater distances between classrooms. Certain class schedules in the College of Liberal Arts may involve walking a distance of three-fourths of a mile in ten minutes by students on the campus involved in this study. Juniors and seniors are known to take into consideration this necessary walking load in their election of courses.

STATEMENT OF PROBLEM

This study was concerned with measuring, by means of a pedometer, the basic walking load of university women in attending classes. A special attempt was made to exclude measurement of walking during any leisure-time activity.

PROCEDURE

Description of the Pedometer.—The pedometer used in this study was recently reported in another article, "Measuring the Walking Load of Nurses in Service and in Training" (1). The pedometer is described as follows:

> The instrument consisted essentially of a cyclometer fastened to an adjustable waist belt. The cyclometer was equipped with a built-in clutch. From the cyclometer projected a flat metal rod of sufficient length to reach the knee and equipped with an adjustable garter, whereby the lower end of the metal rod could be attached to the leg, just above the knee. Suitable gears recorded each swing of the leg from a forward to a backward position. The clutch prevented any reverse movement of the gears during the period of extension or otherwise. The instrument therefore recorded every swing of the thigh in the one direction chosen for measurement, and indicated the exact amount of such movement.
>
> The metal rod was sufficiently flexible so that it could be fitted closely along the thigh and was slotted, the garter attachment fitting into this slot. Thus, the instrument could be worn by individuals of varying heights.

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Figure 1 illustrates proper adjustment of the pedometer.

Reliability of the Pedometer.—The arithmetic mean of units recorded by the pedometer per each mile walked by seven different subjects was found to be twenty. Thus, each unit change by the

Fig. 1. Proper adjustment of the pedometer.

pedometer represents two hundred and sixty-four feet. The pedometer could be accurately read to one-tenth of a unit or 26.4 feet. The maximum error that could be made in reading the pedometer would then be 26.4 feet. It is possible to estimate the approximate distance moved by the dial between the recorded 0.1 units. In such event the value of each 0.01 unit would be 2.64 feet.

The reliability of the pedometer was further determined by mapping out a straight one-mile course on a level street. Seven different subjects walked this distance, alone, with the subject in each instance setting her own pace. The subjects were instructed to follow the right-hand side of the sidewalk in order that a straight course could be more closely approximated.

It will be noted that in those instances in which the change in the pedometer was not the same (Table I), it was greater in all instances on the second mile. It is believed that these differences may be due to a shortening of the stride because of slight fatigue on the second trial. The shortening of the stride obviously would result in a greater number of steps in covering the same distance. This in turn would result in a larger reading on the pedometer during the second mile.

TABLE I

PEDOMETRIC CHANGES PER MILE

Subject Number	*First Mile in Units*	*Second Mile in Units*	*Pedometric Difference in Units*	*Calculated Difference in feet for each subject*
1.	19.00	19.50	00.50	138
2.	23.25	23.75	00.50	113
3.	23.20	23.40	00.20	45
4.	15.20	15.30	00.10	34
5.	19.90	20.00	00.10	26
6.	21.00	21.00	00.00	00
7.	19.40	19.40	00.00	00

The data presented in Table I indicate that a pedometric unit does not necessarily correspond to a definite linear measure. Thus, in seven subjects, the number of pedometric units per mile ranged between 19.00 (each pedometric unit corresponding to 277 feet) and 23.25 (each pedometric unit corresponding to 227 feet). Thus, as between the seven individuals tested, there was a spread of 50 feet in the linear equivalent of a pedometric unit. This individual variation must be due to differences in gait, and not to differences in the pedometers used, as the ten instruments employed in this study were identical in construction.

This variation in linear measurement by the pedometer with individual subjects made it necessary to have each girl walk a known distance, prior to the regular test period, so that the pedometric units could be recorded and evaluated. This figure was then used in interpreting the total walking distance for that particular individual.

Variation in linear measurement by the pedometer in comparing one subject with another can be explained in part by the height of the individual. Tall individuals would tend to have a longer natural stride, with the result that the pedometric scale unit change would be proportionately less than in the case of a short individual. This was shown to be true by having two very tall subjects walk a mile course. Each covered the mile in only 14 pedometric scale units. These two subjects are not included in Table I.

Similarly the fast-walking subject would have a smaller pedometric scale unit change per mile as compared with the slow-walking subject of the same height. The leg in fast walking, being more

shortened than in the slow gait, also swings in a much larger arc (2). The pedometer only measures the degree of pendulum swing of the thigh, being attached at the waist and above the knee. In fast walking there is a complete extension of the lower part of the leg. The degree of this extension is not measured by the pedometer. This fact is believed to account for the variation in pedometric scale unit change with the same individual when there is a change in gait.

A preliminary study (1) "indicated that the ordinary 'watch-type' pedometer was not sufficiently accurate for a study of this kind." This type of pedometer registers each stride by movement of a pendulum within the instrument. Movement of the pendulum is initiated by the jar which results when the subject's heel comes into contact with the surface upon which he or she walks. In some subjects the jar resulting from contact of the heel with the surface is insufficient to cause movement of the pendulum and the instrument fails to record entirely. In an attempt to make use of this pedometer the instrument was worn in a belt over the hip, and in an attempt to produce movement of the pendulum, it was also worn attached to the knee. When subjects walked a measured course repeatedly, there was such a deviation in the results that this type of pedometer was discarded.

The pedometer described herein definitely records each movement of the leg from a forward to a backward position, a feature which appears to be true of no other pedometer heretofore reported. It does not and cannot measure the degree of extension at the ankle which extension affects the factor to be used in converting pedometric into linear units.

Collection of Data.—The average walking load for attending classes was determined on one hundred subjects. Each subject wore the pedometer for one week. Eighty-three percent of the women used in this study were housed in the same dormitory. This was not however a select group, as approximately thirty percent of all women on the campus are housed in this dormitory and the subjects represented a wide variation in their declared major fields. The necessary walking for class attendance took these students to all parts of the campus. Tables II and III give the distribution of subjects according to major interest and year of study.

Individual instruction was given to each subject in adjustment and in proper reading of the pedometer. The pedometer was worn in all instances under the dress. Care was taken in the initial reading to make certain that the waist belt and leg strap were snug so there was no free movement of the pedometer. The pedometer was adjusted in each instance directly over the right hip.

Special forms were supplied to each subject for recording of daily pedometric scale change and for supplying additional information pertinent to the study.

TABLE II

FREQUENCY DISTRIBUTION OF SUBJECTS ACCORDING TO MAJOR INTEREST

Interest	*Frequency*
Physical Education	24
Unclassified	18
Art	8
Psychology	8
Music	6
Commerce	4
Journalism	4
Medicine	4
Zoology	3
Sociology	3
Pre-Medicine	3
Political Science	2
Child Welfare	2
English	2
Education	1
French	1
Health Education	1
History	1
Home Economics	1
Pharmacy	1
Pre-Nursing	1
Mathematics	1
Speech	1
TOTAL	100

TABLE III

BASIC WALKING LOAD OF 100 COLLEGE WOMEN CLASSIFIED ACCORDING TO YEAR OF STUDY

Classification	*Frequency*	*Mean*
Freshmen	26	2.65
Sophomores	24	3.33
Juniors	24	4.48
Seniors	14	4.01
Graduate Students	10	3.82
Unclassified	2	3.59

DISCUSSION AND RESULTS

The basic walking load for the girls under study in attending classes is given in Table IV. The mean walking load per day was found to be 3.8 miles. There was a marked difference as was expected in this necessary walking load. This individual variation is undoubtedly due to a difference in class schedules. Thus, twelve students walked a minimum distance of 5.6 miles daily, while three students had only to walk 1.5 miles or less to meet their daily classes.

Table III indicates no marked change in the mean basic walking load when the students are classified according to year of study. However, the walking load involved during leisure would probably

increase especially during the junior and senior years due to an increased participation in campus activities.

In the institution studied the individual basic walking load is appreciable. This basic load obviously varies with the institution involved. With the present tendency toward expansion, this load no doubt will increase. It seems desirable therefore that for each institution the basic walking load be measured and be taken into consideration in planning the physical education programs for that institution.

It is believed that additional pedometric studies carried out over the entire day will reveal that college women on a campus such as this one should be classified as "moderately active" and not as "sedentary" as has been suggested (3).

CONCLUSION

The mean basic walking load of 100 college women in meeting classes was found to be 3.8 miles daily at the institution studied. The range extended from 0.9 miles to 8.4 miles daily. *These measurements exclude leisure-time activities.*

TABLE IV

FREQUENCY DISTRIBUTION OF THE BASIC WALKING LOAD OF 100 COLLEGE WOMEN IN MEETING CLASSES

Miles per day	*Frequency*
0.6 to 1.5	3
1.6 to 2.5	21
2.6 to 3.5	21
3.6 to 4.5	28
4.6 to 5.5	15
5.6 to 6.5	5
6.6 to 7.5	6
7.6 to 8.5	1
MEAN	3.8
STANDARD DEVIATION	1.5

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A Study of Measurement of Ability in Handball

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(Submitted for publication, May, 1946)

IT was the purpose of this study, (1) to determine the validity of certain skills in measuring ability in handball, (2) to select tests that will bring about game situations for measurement.

There is a real need for scientific measurement of the objectives of the physical education program. Game skills as an objective have been clear in the minds of physical education teachers, yet few tests have been devised that actually measure ability in various sports. This has been a handicap to physical education, resulting in inaccurate grading. It was the writer's belief that standard objective tests should be drawn up in the various activities in order to eliminate ratings, which are generally inaccurate measurements of ability. In making judgment ratings too many factors are allowed to enter the picture. Such items as effort, attitude, interest, and personal prejudices of the rater enter into the rating score.

REVIEW OF THE LITERATURE

Although handball is one of the oldest games played with a ball, the sport in its present form is considered fairly new. Introduced in America by the Irish, it is fast becoming one of the favorite recreational activities of club members and college students. There are several modified forms of the game being played today in public and private playgrounds. These forms are single-wall court, three-wall court and also the softball handball.

Because the present form of handball is so new, very little material has been written about it, nor have techniques or methods of testing been devised. In making up a selected list of books and materials on sports, Ranck wrote in December, 1943, regarding handball:

> For material on this game played in an enclosed room using all six walls, the best place to go is the Spaulding Athletic Library. There are no books on the subject.[1]

In reading the literature available on handball four groups of

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[1] W. M. Ranck, "Outline to Sports and Outdoor Recreation, A Selected List of Books, 1918 to December 31, 1934," *Research Quarterly*, 6: 23-29 (March, 1935).

tests were found. One of these is by Edgren and Robinson.[2] Their series included, in part, the Speed Test, Accuracy Test, Volley Test, Service Test, and Back Wall Return. Some of the skills being measured seem to overlap.

The authors do not claim that this form of test measures all the factors involved in making a good handball player. However, they believe that the technique has some value in measuring the achievement of the individual in his ability to play the game.

The second series was by Clevett. His tests used five strokes in handball. They were the Full-Arm Stroke, Easy-Placement Stroke, Back-Wall Stroke, Service Test, and Overhand Stroke. The front wall and floor was marked off into six equal areas for front wall and nine equal areas for the floor, with numerals denoting the difficulty of each area.

These tests were used for purposes of measuring the progress of pupils after a course of instruction had been given in handball. No validity was established.

The third group was proposed by Friermood.[3] His tests measure ability to perform certain strokes and ability to serve in designated areas, such as right into left and left into right. They vary from other skill tests listed in that no targets or watches are used in the procedure and the scores are based totally on the judgment ratings of the scores.

The three groups of tests mentioned have not been used extensively. No attempts to find the validity or reliability of these tests have been made.

Schiff[4] used the observation procedure in rating students. He had three assistants schooled in the system of checking the success of each player and the ratings by each assistant were totaled and averaged for each student. His findings were very significant, showing a correlation of .87.

PROCEDURE

The data presented in this study were obtained from six physical education classes at Louisiana State University.

There were six four-wall handball courts, limiting the classes to twenty-four students each. The classes met three times each week for thirty minutes a day. Although the classes totaled one hundred and forty-four students only one hundred and thirty-four completed the tests selected.

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2 H. D. Edgren and G. T. Robinson, *Individual Skill Tests in Physical Activities*. Chicago: Published by authors, George Williams College, 1937.

3 H. T. Friermood. *A Handball Study*. Mimeographed.

4 Schiff, T. A. Test of skill performed in the game situation of handball. Unpublished master's thesis, Ohio State University, 1938.

The students were schooled in the fundamentals of the game at the beginning, giving instruction in the proper manner of stroking the ball and the basic rules of the game.

The writer selected six students from each class to aid in recording the scores made by the contestants. The tests selected were the Thirty-Second Volley, Front-Wall Placement, Back-Wall Placement, Service Placement, and Power Test. These tests were selected after much observation and review of literature available on testing in handball. After one week of instruction the above tests were administered to one hundred and forty-four students. Three class periods were required to administer the five tests. After ten weeks of practice and play the same tests were administered again.

DESCRIPTION OF TESTS

Thirty-Second Volley.—The contestant began by standing behind the service line, dropped the ball to the floor and stroked it continuously for thirty seconds. The ball had to rebound far enough from the wall for the contestant to remain behind the service line. In case the ball failed to return, he could step into the front court to strike the ball, but had to return for the succeeding stroke. If the contestant missed the ball another was handed to him by the judge and play continued. A point was recorded each time the ball struck the front wall, and the total points were recorded at the end of 30 seconds.

Front-Wall Placement Test.—The front wall was divided into areas as shown in Figure 1. This pattern was selected after much experimentation. The areas as shown were found to range from very easy to very difficult. The smaller areas containing the larger numerals were more difficult than the smaller numerals.

Starting from the service line the contestant tossed the ball to the front wall below a line drawn six feet above the floor; on its rebound he struck the ball, striving to place it in the area containing the largest numeral. The contestant stroked the ball five times with the right hand and five times with the left hand. The total number of points were recorded. After striking the ball on the rebound it was tossed to the front wall on each succeeding try.

Back-Wall Placement Test.—The judge tossed the ball so that it would strike the back wall approximately three feet above the floor on each try. The ball was stroked by the contestant who attempted to strike the largest numbers on the front wall. The same pattern was used as in the front-wall placement test. Five strokes were made with the right hand and five with the left hand. The total number of points was recorded.

Power Test.—The floor of the court was divided into five areas

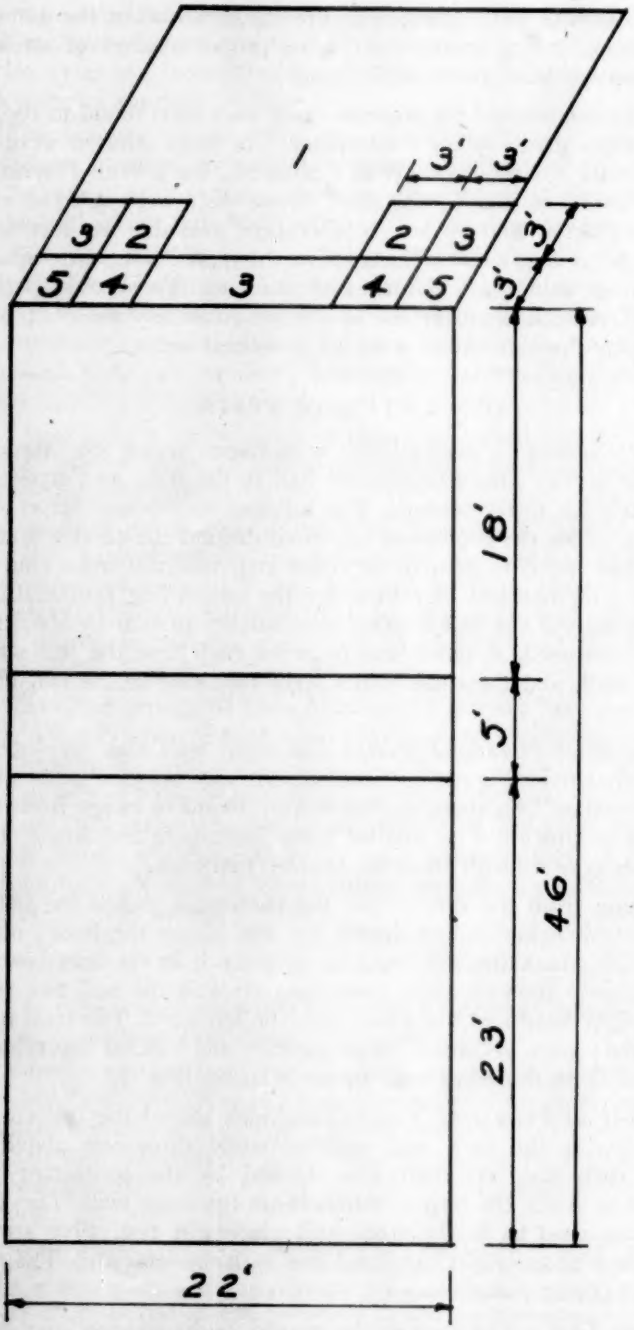

Fig. 1. The difficulty of various positions on the front wall and their values.

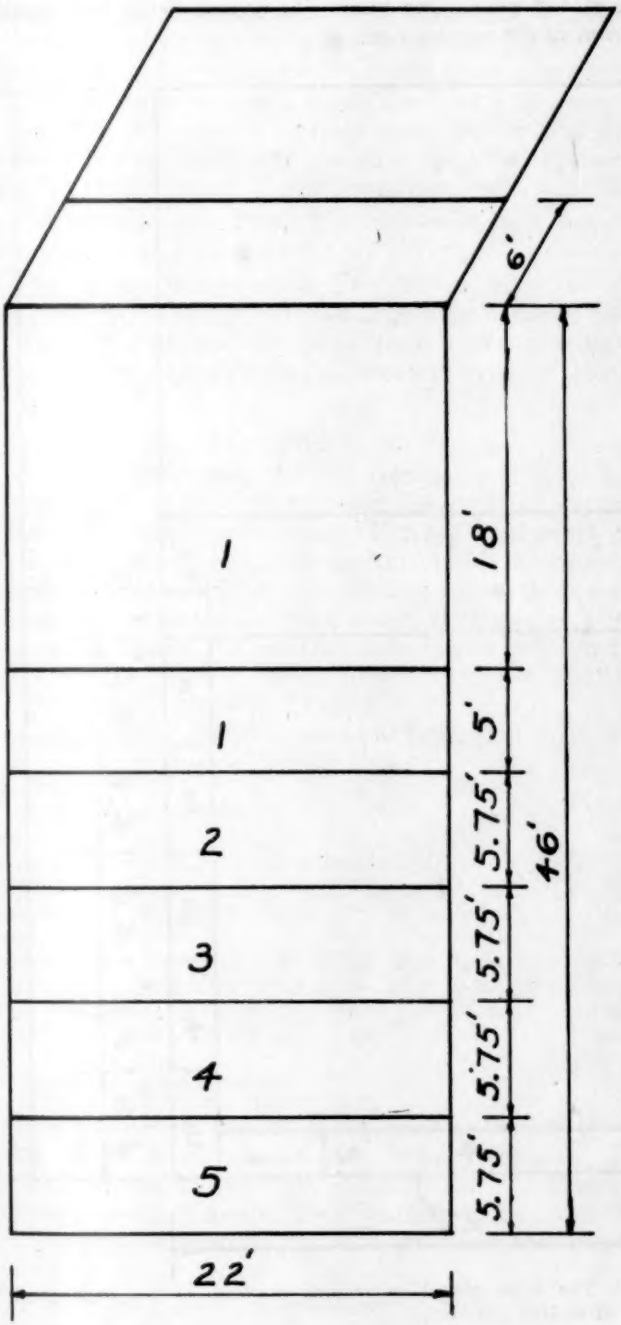

Fig. 2. The value placed on various areas of the court relative to power in handball.

as shown in Figure 2. One point was scored if the ball struck the floor in front of the service line.

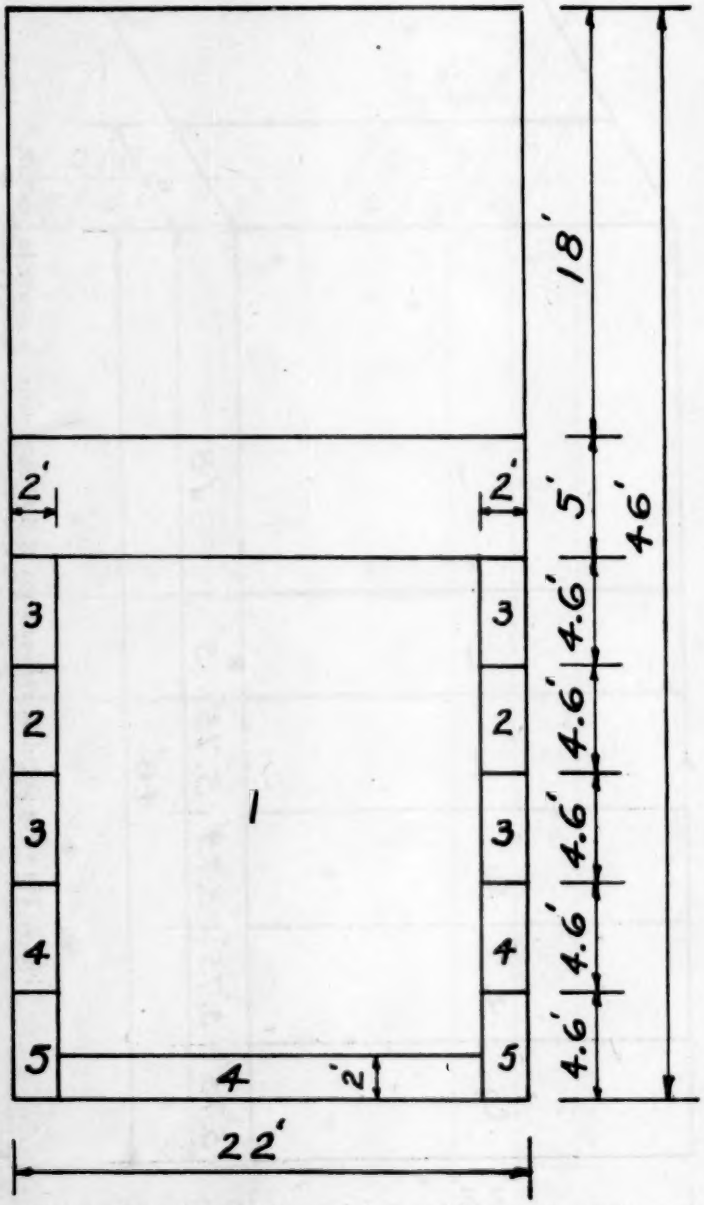

Fig. 3. The value placed on various positions of the back court relative to service placement.

Standing in the service zone the contestant tossed the ball to the front wall, allowing it to bounce before striking it. The ball, after being stroked, had to strike the front wall below a line six feet above the floor. In the event that it struck the front wall above the line or the contestant stepped into the front court, another trial was allowed. Five strokes were made with the right hand and five with the left hand. The total number of points was recorded.

Placement-Service Test—The back court floor was divided into areas as shown in Figure 3.

The contestant was allowed ten serves. Five had to be cross-court services. All serves were with the hand normally used in serving. The above pattern was taken from a similar pattern used by Phillips[5] denoting the difficulty of sidewall placement. The total score was recorded.

TREATMENT OF DATA

As stated previously the five tests selected were administered the second week of the class and after ten weeks of play and practice the tests were administered again. The last four weeks of the class were used to play games, each student playing 23 games. The total number of points scored by each student minus those scored by his opponent was tabulated and these points were used as a criterion for measurement against the five tests as indicated in Table I.

TABLE I

INTERCORRELATION OF THE FIVE SELECTED TESTS WITH TOTAL NUMBER OF PLUS POINTS

Total Points	0	1	2	3	4	5
30-Sec. Volley	.53 ± .0418*					
Front-Wall Placement	.51 ± .0431	.42 ± .0461				
Back-Wall Placement	.38 ± .0498	.38 ± .0498	.42 ± .0461			
Service Placement	.53 ± .0418	.28 ± .0536	.26 ± .0543	.26 ± .0543		
Power Test	.58 ± .0386	.41 ± .0474	.49 ± .0442	.60 ± .0351	.51 ± .0431	
Mean	51.3	17.10	21.98	21.46	16.98	13.93
P.E.M.	.189	.171	.148	.195	.169	.122
S.D.	9.26	2.93	2.55	3.55	2.91	2.1

* Reliability of the coefficient.

The multiple correlation of the five tests with the total number of plus points on games won was found to be .694. The highest individual correlation with the criterion was the Power Test, .58. The lowest correlation with the criterion was the Back-Wall Placement, having a correlation of .38. The lowest intercorrelation was

[5] Phillips, Bernath G. *Fundamental Handball.* Rev. New York: A. S. Barnes and Co., 1940, p. 60.

the Service-Placement Test with the Front-Wall Placement Test, and Back-Wall Placement, both having a correlation of .26.

A combination of the Thirty-Second Volley and the Service Placement Test with the criterion was found to have a correlation of .667.

SUMMARY AND CONCLUSIONS

The purpose of this study was an attempt to develop techniques for measuring the ability of handball players.

Data were gathered from 134 students enrolled in handball classes at Louisiana State University. The tests were administered during the class period.

The criterion used in correlation of the tests was the total number of plus points scored by each student over his opponent in twenty-three games. Several students had a total of minus points.

If only one test were selected, the Power Test would probably be the best as it had a rather significant correlation with all other tests. The best battery of tests would probably be the Thirty-Second Volley and Service-Placement Test as they have a .667 correlation with the total number of plus points scored.

Research Abstracts

Prepared for the
NATIONAL COUNCIL OF THE RESEARCH SECTION

by

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NUTRITION

Chieffi, Margaret, and Esben Kirk. Vitamin studies in middle-aged and old individuals. *J. Nutrition,* 37:1 (January, 1949).

A clinical study of 106 individuals with regard to signs of vitamin A deficiency revealed a considerably higher frequency of occurrence of hyperkeratosis of the skin follicles and of localized conjunctival thickening in the subjects with a low vitamin A plasma level (1-15 ug %) than in those having a higher plasma vitamin concentration (25-60 ug %). The occurrence of dryness of the skin and of blepharoconjunctivitis was also more frequent in the subjects with hypovitaminemia A, but the difference between the groups was not marked.

No correlation was found between dark adaptation time and vitamin A plasma values but a significant, though moderate, correlation was observed between length of adaptation time and age. The percentage of keratinized cells in conjunctival smears was slightly higher in individuals with low vitamin A plasma values, but the percentage variation between different subjects and between the two eyes of the same subject was so great as to invalidate the clinical usefulness of this examination. No correlation was observed between the vitamin A plasma concentration and the number of epithelial cells excreted daily in the urine, nor between the plasma value and the percentage of keratinized cells in the urinary sediment.—*Wistar Institute.*

Bricker, Mildred, Ruth F. Shively, Janice M. Smith, Harold H. Mitchell, and Tom S. Hamilton. The protein requirements of college women on high cereal diets with observations on the adequacy of short balance periods. *J. Nutrition,* 37:2 (February, 1949).

The adequacy of protein requirements for longer periods estimated during short balance periods (10-12 days) was assessed in a 10-week feeding test with 10 women 19-30 years of age. The average daily protein requirement for nitrogen equilibrium and "adult growth" was found to be 31.7 gm when protein was furnished by white bread, oatmeal, beef, cream, and potatoes in proportions to supply 70 percent of the protein from cereals. The individual estimated requirements, with one exception, appeared adequate when fed during the 10-week period, since continuous storage of nitrogen resulted and hematologic data and responses to performance tests remained relatively constant. The average daily nitrogen balance figures for the 9 subjects who showed continuous positive balances were as follows during weeks 1-10 respectively: 0.780, 0.833, 0.750, 0.718, 0.645, 0.796, 0.493, 0.618, 0.422, and 0.786 gm.

The authors conclude, as a result of these data, that "protein requirements computed from experimental periods of such length that the urinary nitrogen attains a relatively constant level are valid for periods of at least 70 days.—*Wistar Institute.*

PHYSICAL ANTHROPOLOGY

Howells, William W. Birth order and body size. *Am. J. Phys. Anthrop.* (ns), 6:4 (December, 1948).

This paper presents some results of an anthropometric study of brothers,

drawn mostly in pairs from the student body of the University of Wisconsin and yielding a maximum of 97 pairs. The study was done as one attempt to find methods of controlling environmental factors in the determination of body size and form, and the principal factor considered in this paper is order of birth. If birth order, taken alone, has any constant influence on adult body form, this has yet to be demonstrated. Bowles found indication that among Harvard brothers of a generation or so ago the younger brothers had a constant size advantage, quite apart from the secular increase in stature. In the present sample, when Wisconsin brothers were compared simply as series of "older" and younger," no corroboration of Bowles' results was found. There was an advantage for the older brothers, especially in body and limb lengths, of a degree too slight to be reliable. A more careful comparison, by actual pair differences according to birth orders, was no more revealing. Fraternal coefficients of correlation differ considerably in different measurements, with longitudinal measurements generally showing a stronger correlation between brothers than measurements of breadth.—*Wistar Institute.*

Strandskov, Herluf H., and Julius A. Roth. A comparison of rural and urban birth sex ratios for the total, the "white," and the "colored" U.S. populations. *Am. J. Phys. Anthrop.* (ns), 7:1 (March, 1949).

The percentages of males for live births and stillbirths within the total, the "white" and the "colored" rural and urban U.S. populations, for the 15-year interval from 1922 to 1936, are calculated and compared. It is found that the rural live birth sex ratios are not significantly different from the urban. The percentage of males for rural stillbirths is found to be higher than that for urban stillbirths. This is attributed in part to a differential in the reporting of early stillbirths. Both "white" rural and urban populations are found to have a higher percentage of males for live births than corresponding "colored" populations. This is attributed in part to differences in percentage of stillbirths, and in part to racial differentes in genetic factors. "Colored" rural and urban populations are found to have slightly higher percentages of males for stillbirths than corresponding "white" populations. These differences are attributed primarily to higher percentages of stillbirths for "colored" populations. The higher percentages of stillbirths for the "colored" population are assumed to be due primarily to environmental rather than to genetic factors.—*Wistar Institute.*

Howells, William W. Body measurements in the light of familial influences. *Am. J. Phys. Anthrop.* (ns), 7:1 (March, 1949).

Workers in anthropometry have been apt to assume that one measurement of the body was as good as another for purposes of comparisons of racial or other groups. In the present paper this assumption is tested by examining pairs of brothers to determine whether they differ more in some body measurements than in others, taking as the basis of comparison the average difference between randomly selected members of the same population. Both the absolute deviations and the critical ratio are used to compare the measurements with one another. In this respect, the measurements which are most responsive to this factor of brotherhood are longitudinal measurements, above all those of the bones of the lower leg and arm and the heights of the facial skeleton. Total stature is one of these, but it is suggested that this is largely traceable to the contribution of the legs, since sitting height gives the lowest proportionate difference among the longitudinal measurements. Longitudinal, antero-posterior, and transverse measurements of the head are perhaps less distinguished than those of the body. Bi-iliac and biacromial breadths are low, with nose breadth, ear length, and ear breadth bringing up the rear. There thus appear to be clear

differences in how critical various measurements are, when tested by this one criterion.—*Wistar Institute.*

Hunt, Edward E., Jr. A note on growth, somatotype, and temperament. *Am. J. Phys. Anthrop.* (ns), 7:1 (March, 1949).

Sheldon's view of somatotype as a simple predominance or balance of one or more of the embryonic germ layers is not entirely adequate. Six-month fetuses show great consistency in the relative contributions of various tissues to the total body weight, and hence the somatotypes at this age are probably not well differentiated. *Endomorphy* in the adult is best described as a retention of a growth phase which reaches a peak at the postnatal age of 9 months. It may also be the outcome of a steep proximodistal growth gradient which exaggerates central rather than peripheral growth. *Ectomorphy* is a retention of the growth phase of childhood which reaches a peak at the age of 9 years. It may result from a steep cephalocaudal gradient which produces a full-sized head on a puny body. *Mesomorphy* is an exaggeration of an adolescent growth stage. A transient shift toward androgyny often occurs as the secondary sex characteristics begin to develop in either sex. Perhaps both environment and heredity affect the duration and retention of effects of these various stages. A plan is offered whereby somatotype criteria for women could be established through growth studies on both sexes. Viscerotonia is presumably the infantile temperament, cerebrotonia the temperament of later childhood, and somatotonia is a prominent trend in adolescence in Western culture. It is not unlikely that these tendencies are considerably alterable through cultural influences.—*Wistar Institute.*

PHYSICAL FITNESS

Education of the body. *The Lancet,* 253:139-140 (July 26, 1947).

Among doctors and physiologists interest in physical education has mostly been desultory. Feats of strength and athletic competitions have always had their appeal—not least to those whose own endowments in such directions are meagre. But only comparatively recently has it occurred to research workers that the physical performance of the spectators themselves can be vastly improved, with corresponding benefits to their health.

In South Africa and the United States a good deal has been done on these lines in the past ten years and from the former country we now have a report by the medical research committee of the National Advisory Council for Physical Education (*Manpower,* 1946, 4, 1). Written by Dr. Jokl, it describes work which stems from the 1933-39 experience of reabling European unemployed at Roberts Heights by physical education within the framework of a paramilitary organization (Jokl, E., *et al., Training and Efficiency.* South African Institute for Medical Research, 1941). The South African investigators have measured the heights, weights, chest circumferences, upper-arm circumferences, and hip widths of a large number of white and Bantu children between the ages of 7 and 16, and they present the usual growth curves for these subjects (*Manpower,* 1944, 3, 2). The Bantu begin their adolescent spurt in growth considerably later than do white children studied elsewhere; how far this is due to heredity and how far to environment is not discussed, but other evidence indicates that malnutrition delays the appearance of the growth spurt and the menarche (Ito, P. K. *Human Biol.* 1942, 14, 279). These children and others (including coloured, Indian, and Chinese) were given three tests of physical efficiency: the time to run 100 yards, the time taken to run 600 yards, and the distance that a 12-pound shot could be put. Growth curves for each group are given for these items, which are said to measure respectively skill, endurance, and strength.

The shot-put curve exhibits the well-known phenomenon of an increase of strength at puberty, as shown, for example, in the work of the Galton laboratory (Ruger, H. A., and B. Stressiger. *Ann. Eugen.* 1927, 2, 76). Jokl and his associates believe that, so far as running ability is concerned, puberty has an adverse effect, and that increase in efficiency "comes to a standstill with the onset of puberty"; but this conclusion conflicts with those reached in the University of California Adolescent Study (Espenschade, A. Motor performance in adolescence. Also, *Monogr. Soc. Res. Child. Dev.* 5:1, 1940, and Jones, H. E. *Human Biol.* 1947, 19, 12). In California it was found that the adolescent spurt in growth is associated with improvement in the times of track events—and indeed all athletic performance—as would be expected from the increased growth of the muscles. By the end of puberty, at about 13½ in girls and several years later in boys, adult standards are for the most part established, apart from practice and training effects; indeed girls' performances over the 50-yard dash worsened between the ages of 13 and 16. The time of the adolescent spurt varies from one child to another, and these physiological changes vary with it. Early maturers, who reach their maximum velocity of growth early and who menstruate early, settle down early to their adult standards for running and for pulling on the dynamometer, and adjust early to their adult levels for blood-pressure, heart-rate, and oxygen consumption (Shock, N. W. *Amer. J. Physiol.*, 1943, 139, 288). The sex difference in performance is also largely due to the adolescent spurt: before this time, boys are but slightly better than girls, but the growth spurt is much greater for boys, and it brings muscular superiority. A second look at Jokl's data shows that they are in fact consistent with these findings; it is only the interpretations which differ. In view of the predominance of Negroes in athletic sports it is interesting to note that in the running events the Bantu children, despite their worse economic and nutritional circumstances, were slightly superior to the whites.

An extensive clinical survey of Bantu children suggested that the chief cause of their medical defects, which were many, was malnutrition. Among Moslem Indian children it was found that running and weight-putting efficiency decreased during the fasting month of Ramadan, when the children had nothing to eat between an early breakfast and the time of their test. Another noteworthy observation was that "physically substandard" adolescent boys gained more weight during a nine months' physical-training course than normal boys of the same weight would have done, without training, in the same period. On the question of whether or not physical training can harm the hearts of young people Jokl concludes that it cannot; in the reported sudden deaths of supposedly healthy men during or after athletic performances some other pathological change entirely unconnected with activity can always be demonstrated, he says. A discussion on the philosophy of physical fitness includes a statement that the psychologist who took part in the investigation concluded that girls are superior in "morality" to boys. "There is a sudden marked drop in morality scores in boys when they become 13 years old. Girls do not show such a drop. They continue to progress steadily upward notwithstanding the fact that at the same time their physical performance scores remain behind those achieved by boys, or even decline."

More comprehensive work on physical fitness tests has lately appeared from the University of Illinois school of physical education, in a monograph by Cureton, *et al* (Cureton, T. K., *et al.* Endurance of young men. *Monogr. Soc. Res. Child. Dev.*, 10:1), who have analyzed the repeatabilities and interrelationships of 28 tests of physical endurance, mostly of the gymnastic type, but including several running events. The statistical technique used is factor analysis, and a combination of scores in 4 tests, chinning the bar, backward leg-raisings, side

leg-raisings, and the mile run, has been found which can be used to evaluate a given person's overall endurance capacity. Further analysis shows that the tests fall together in groups: factors of running endurance, of lateral muscles, of shoulder-girdle and pelvic-girdle muscles (which go together, as one might expect), and of arm-extensor muscles emerge.

Cureton also goes in detail into the endurance relationships of the Harvard step test (pulse-rate after stepping up on a bench and down again 30 times a minute for five minutes) and the old Schneider index (a combination of lying pulse-rate, standing pulse-rate, pulse-rate change from lying to standing, pulse-rate increase after exercise, time for pulse to return to first value after exercise, and change in systolic blood-pressure from lying to standing). Analysis of the Schneider index shows that two of its items contribute no further information after the other four have been considered, and a modified index is presented which omits pulse-rate and blood-pressure change from lying to standing. This modified index predicts ability in running endurance (an average of 4 scores, for 1-mile run, 2-mile run, 3½-mile steeple-chase, and 1000-yard run) fairly well, but only for a group of men who are keen to do their best, and who are neither very fat nor very thin. Body build turns out to have a great deal to do with endurance in running; in the Sheldon terminology (Sheldon, W .H. *Varieties of Human Physique*. New York, 1940) endomorphy decreases and ectomorphy increases it; *i.e.*, fatness worsens performance and slimness improves it. Running endurance depends on motivation, skill, physique, and cardiovascular condition. The modified Schneider index measures, imperfectly, only the last of these. Thus, the search for measures of physical fitness is being continued partly in the schools of physical education and in the field, where tests are devised, large numbers are tested, and training may be carried out, and partly in the physiological laboratories, where the effects of exercise itself are slowly being unravelled.—*T. K. Cureton.*

PHYSIOLOGY

Huddleston, O. I., and J. G. Golseth. Electromyographic studies of paralyzed and paretic muscles in anterior poliomyletis. *Arch. Physic. Med.*, 29:92-98 (1948).

Twenty confirmed cases of anterior poliomyletis were studied by photographing electromyograms obtained by means of an oscilloscope. Fibrillation was observed in many paralyzed and paretic muscles 21 to 30 days after onset of "polio." In general, there was an inverse relationship between incidence of fibrillation and muscle power. No complete functional recovery has been observed in those muscles which exhibited fibrillation throughout their lengths 21 to 40 days after onset. This study furnished additional data of diagnostic and prognostic value.—*Peter V. Karpovich.*

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Since three members of the Board of Associate Editors review an article it is requested that at least two copies of the manuscript (the original and a clear carbon) be submitted in order to facilitate reviewing. One copy of the article should be retained by the author for checking against galley proofs. Manuscripts should be double spaced.

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